Maritime Analytics Prototype

Phase 3 Validation Final Report

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Abstract

This report documents user validation of the Maritime Visual Analytics Prototype (MVAP), a test-bed and showcase for novel visual analytics strategies in support of maritime situation awareness, anomaly detection, and detailed analyses of Vessels of Interest (VOIs). MVAP components can be used independently or integrated into Defence Research and Development Canada's (DRDC's) Widget Application Shell (WAS) framework in the Intelligence Science and Technology Integration Platform (ISTIP).

Validation trials were done with three objectives:

- Evaluate the usability of MVAP apps and services

- Estimate the potential impact of MVAP on MSOC productivity

- Identify potential future improvements of MVAP components.

A "User Jury" methodology was used, in which four groups of Marine Security Operations Center (MSOC) analysts (totaling 16 persons) were given a thirty minute hands-on lesson in how to use MVAP, and then challenged to achieve six new tasks in fifteen minutes using the MVAP tools. The challenge tasks focused on maritime domain awareness using previously-recorded real data from the Global Positioning Warehouse (GPW) dataset.

Trial participants reported on the perceived value of the new apps using the internationally-recognized System Usability Scale (SUS). Participants were observed and their actions were recorded during both the training and the challenge segments of the trials, with particular attention paid to successful tasks, errors made, and self-learning. Data was collected through observations, the standard SUS questionnaire, and participants' comments at a Hot Wash-Up discussion. The quality of the apps was assessed using standard SUS scoring.

End-user response to the trial was very enthusiastic. The average SUS score was 76/100 which is considered "Excellent" in the scientific literature. Comments from participants indicated that MVAP may lead to a significant improvement in productivity over the MSOC's current tools, and the analysts are keen to have it on their desks. The Map and Timeline app generated the most comments because of its ability to visualize the time evolution of the maritime picture, and because it can detect close encounters between vessels. The Magnets Grid app also drew a lot of praise because it offers a completely new way to explore numerical and textual attributes of vessels.

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Résumé

Ce rapport documente la validation du Prototype d'Analytique Visuelle Maritime (PAVM) par les usagers; un banc d'essai et de démonstration pour de nouvelles stratégies d'analytique visuelle en support à l'analyse de la situation maritime, à la détection d'anomalies et à l'analyse approfondie de navires d'intérêt. Les composantes du PAVM peuvent être utilisées indépendamment ou intégrées au cadriciel Widget Application Shell (WAS) de Recherche et Développement pour la Défence Canada (RDDC) sur la plateforme d'intégration Intelligence Science and Technology Integration Platform (ISTIP).

Les essais de validation ont été réalisés avec trois objectifs :

- Évaluer l'utilisabilité des apps et services du PAVM

- Estimer l'impact potentiel du PAVM sur la productivité des Centres des opérations de la sûreté maritime (COSM)

- Identifier des elements d'améliorations futures potentielles des composantes du PAVM.

Une méthodologie "User Jury" a été employée. Quatre groupes d'analystes du Centre des opérations de la sûreté maritime (COSM) (pour un total de 16 personnes) ont reçu une formation pratique sur l'utilisation du PAVM et ont ensuite tenté d'accomplir six nouvelles tâches en quinze minutes en utilisant les outils du PAVM. Les tâches portaient sur la connaissance de la situation maritime et utilisaient des données préenregistrées réelles provenant de la base de données Global Positioning Warehouse (GPW).

Les participants de l'essai ont évalué la valeur perçue des nouvelles apps à l'aide du System Usability Scale (SUS) qui est reconnu internationalement. Les participants ont été observés et leurs actions notés pendant le segment formation autant que pour la partie évaluation des essais, avec une attention particulière portée envers les tâches réalisées avec succès, les erreurs effectuées et l'auto-apprentissage. Des données ont été récoltées à l'aide d'observations, des questionnaires SUS standards et des commentaires des participants lors de la discussion après exercice. La qualité des apps a été calculée en utilisant le pointage standard SUS.

La réception du PAVM par les usagers finaux a été très enthousiaste. Le pointage SUS moyen était de 76/100, ce qui est considéré « Excellent » dans la littérature scientifique. Les commentaires des participants ont indiqué que le PAVM promet des améliorations significatives de la productivité par rapport aux outils actuels du COSM, et les analystes sont désireux de l'avoir dans leur environnement de travail. L'app Map and Timeline est celle qui a généré le plus de commentaires en raison de sa capacité de visualiser l'évolution temporelle de la situation maritime et parce qu'elle permet de détecter les rencontres rapprochées entre des navires. L'app Magnets Grid a aussi reçu une bonne appreciation car elle permet d'exploiter les propriétés numériques et textuelles liées aux navires d'une manière complètement nouvelle.

Executive summary

Maritime Analytics Prototype Development: Validation Final Report

Eric Hall; Mike Davenport; Neil Bozowsky; William Wright; DRDC Valcartier TR [enter number only: 9999-999]; Defence R&D Canada – Valcartier; November c; Unclassified.

Introduction or background:

This report documents user trials and performance assessments in Phase 3 of a Maritime Visual Analytics Prototype (MVAP) test-bed implementation. This work was done under Advanced Research Project (ARP) 11jm (previously 11hm) "Maritime Domain Analysis through Collaborative and Interactive Visualization." It builds on earlier requirements analysis, literature and product survey, design, architecture, and implementation contracts.

This research specifically examines how Visual Analytics can help surveillance agencies achieve better maritime domain awareness by offering cognitively rich representations, information filtering and clutter reduction capabilities, multimodal interactions, and teamwork collaboration services. To avoid reproducing already well-established and widely used software systems, the focus is on developing compact apps (a commonly-used abbreviation for "applications") or widgets that might be incrementally added to existing surveillance systems. For the project, Oculus was responsible for project management, technical architecture, user experience design refinement, software development and demo scenarios. Salience was responsible for subject matter expertise, analysis, design, refinement, demo scenarios, and trials data synthesis.

MVAP was implemented using a Service Oriented Architecture with JavaScript and Java code. The following apps were developed and tested: Analysis Sets, Vessel Summary Card, Record Browser, Map and Timeline, Magnets Grid, and Events Timeline.

Methodology:

An early onsite planning session was held in Halifax ten months before the validation event. Nineteen MSOC analysts representing the Royal Canadian Navy (RCN), Coast Guard, RCMP, and CORA were briefed on MVAP capabilities and gave suggestions that influenced the tasks and datasets for the validation.

The MVAP apps and services were evaluated to determine how well they help analysts' effectiveness, efficiency, and satisfaction. This was measured through hands-on User Jury trials with the generous participation of personnel from the Marine Security Operations Center (MSOC) in Halifax. Trial data included data recorded at the MSOCs, new information scraped from the web, and hand-crafted or computer-generated data to support scenarios of interest. Subjects were given thirty minutes of hands-on training, and then asked to perform six tasks using the new apps.

Two types of assessment were made:

- Observations and Anecdotes: Interaction with the new apps was observed during both the training and the task-focused halves of the trial. Usability metrics included interaction (e.g.

immediate feedback), errors, critical incidents (e.g. recovery from error) and self-learning (i.e. discovering capabilities that were not taught).

- Subjective Assessments: Participants were invited to give subjective assessments of perceived effectiveness, efficiency, correctness, satisfaction, and trust of each feature using the internationally recognized system usability scale (SUS).

Results:

The average SUS score was 76/100, which corresponds to "excellent."

Verbal reports from the participants were enthusiastic including (paraphrased):

- "This is better than what we have now."
- "Very useful – can't wait to use it, when do we get it?"
- "This is a tool that an analyst would use."
- "The GUI was intuitive enough that participants were trying features without waiting for training"
- "All apps represent concepts that would greatly improve the visual analysis"

In their comments, participants were thinking ahead to how MVAP could be integrated into MSOC. They also asked whether MVAP could also be used in a context disconnected from the MSOC data grid. They made suggestions for data exchange with existing systems, adding configurability to match their task-specific requirements, and extending the capabilities of some apps. They also made suggestions for improving the user interfaces.

The Map and Timeline app was flagged by some as "the best app of all." Participants appreciated how it visualized time evolution, showed vessels interacting, and displayed Close Encounters information. They stated that it is almost impossible to detect close encounters with the tool suites currently at the MSOCs. Magnets Grid was also popular, in part because it is surprisingly simple to use and provides uniquely valuable insights.

Documentation

This document provides full documentation of the trials and trial results. A complete description of the methodology is provided, including a training script and a script for the exercise. The original hand-written comments and observations are reproduced in Annex B, and all the comments are assembled, sorted, and interpreted in Tables 1 through 6.

Future plans:

This document concludes by outlining the steps required to deploy the MVAP apps to an operational environment.

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1   Background and Functional Context

This is the Validation Report of the Maritime Visual Analytics Prototype (MVAP) development contract W7701-135425 [17]. The work was conducted by Oculus Info Inc. and Salience Analytics Inc. from September 2012 through December 2013.

1.1   Context and Background

The MVAP has been developed to address specific needs of the MSOC partners and the Canadian Forces in protecting the maritime approaches to Canada. In order to effectively assess the value of MVAP, it is appropriate to first summarize what those needs are, and highlight how Visual Analytics can contribute to meeting them. Section 1.1.1 thus provides a summary of maritime surveillance context and operational challenges, and Section 1.1.2 introduces the government agencies that work together to meet those challenges. Section 1.1.3 provides a brief introduction to Visual Analytics.

Visual Analytics is not the only technology that is potentially relevant to Maritime Domain Awareness, and DRDC has explored many other strategies. Sections 1.1.4 and 1.1.5 reference some of those other initiatives.

1.1.1   Maritime Domain Awareness

Maritime domain operators and analysts around the world have a mandate to achieve Maritime Domain Awareness, which is defined as follows:

- "Maritime Domain Awareness is the effective understanding of everything on, under, related to, adjacent to, or bordering a sea, ocean or other navigable waterway, including all maritime-related activities, infrastructure, people, cargo, vessels, or other conveyances." [16]

This mandate is based on the need to protect from attack, defend sovereignty, detect illegal activities, and support search and rescue activities. Operators and analysts maintain 24/7 watch over the oceans in support of the mandate. They do so by extracting and analyzing situational facts from a variety of sensor data streams and analysis tools.

In Canada, the Marine Security Operation Centres (MSOCs) (see Section 1.1.2) rapidly process a variety of information streams in order to develop shared situational awareness, which is communicated through the "Recognized Maritime Picture" (RMP), a shared multi-modal description of all that is known. Key goals of this analysis are to:

- Understand what the observations mean, and thus

- Anticipate what may happen next, so that appropriate action may be taken in a timely manner.

Such insights are more likely to be achieved if the MSOC agencies share their data streams and work together to interpret them.

This goal of rapid, collaborative extraction of meaning from high-volume data streams is very challenging because of:

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- The large number and diversity of data, information and knowledge types and sources;

- Significant information overload;

- The incomplete / uncertain nature of the information; and

- The need for timeliness in the resulting RMP.

1.1.2   Marine Surveillance Operational Centres

Responsibility for gathering Maritime information, and for responding to actionable information, is divided among the member agencies of the Marine Surveillance Operational Centres (MSOCs) [11]. The identities and roles of these agencies can be summarized as follows:

- **Royal Canadian Navy and the Canadian Forces:**

  - **Surveillance Role:** host agency for the Halifax and Esquimalt MSOCs, lead agency for assembling the global Recognized Maritime Picture, operator of the CF maritime surveillance aircraft, ships, and sensor systems, and primary point of contact for exchanging information with international military surveillance agencies. Maintains situational awareness throughout Canada's area of responsibility (which extends beyond Canadian territorial waters) and in selected regions around the world, such as around Canadian warships. CF is not allowed to collect information on Canadian citizens.

  - **Response Mandate:** primary responder for events in international waters, for events involving a foreign warship, and for any maritime act of war against Canada. Frequently requested to support other MSOC agencies (e.g. RCMP) for actions within their jurisdiction.

- **Royal Canadian Mounted Police (RCMP):**

  - **Surveillance Role:** host agency for the Great Lakes MSOC, able to collect some information on Canadian citizens.

  - **Response Mandate:** primary responder for law enforcement against ships in Canadian territorial waters, including the Great Lakes, Atlantic, Pacific, and Arctic oceans.

- **Department of Fisheries and Oceans (DFO) including the Canadian Coast Guard (CCG):**

  - **Surveillance Role:** CCG maintains situational awareness of ship movements in Canadian waters through its Marine Communications and Traffic Services (MCTS) operations centers. They collect call-in data from ships approaching Canadian ports, and track the locations of the ships using their network of shore-based radars and Automatic Identification System (AIS) receivers. DFO flies surveillance aircraft, primarily to monitor fishing zones. Both DFO and CCG operate ships that provide surveillance data. DFO has access to vessel tracking system (VTS) data from fishing boats in or near Canadian waters.

  - **Response Mandate:** CCG enforces conformance to shipping regulations. DFO enforces conformance to fishing regulations and restrictions. Both DFO and CCG can intercept and board ships suspected of infringing regulations.

- **Transport Canada (TC):**

- **Surveillance Role:** oversees security at Canada's ports, detects marine pollution events, detects regulatory infractions, regulates commercial shipping in Canadian waters, regulates security at offshore facilities such as oil and natural gas drilling platforms.

- **Response Mandate:** imposes regulations, collects evidence, fines or prosecutes offenders, educates and certifies mariners, shares information with other agencies.

- **Canada Border Services Agency (CBSA):**

  - **Surveillance Role:** collects information about cargo and passengers destined for Canada, before they leave a foreign port. They maintain a network of intelligence agents in Canada and abroad to detect threats to Canada's immigration, visitor, refugee and citizenship programs, and to detect contraband products.

  - **Response Mandate:** ability to block entry of persons or cargo into Canada. Provide intelligence reports that can lead to interventions by the RCN or RCMP.

1.1.3   Visual Analytics

A widely accepted summary of Visual Analytics is:

- "Visual analytics is the science of analytical reasoning facilitated by interactive visual interfaces. People use visual analytics tools and techniques to synthesize information and derive insight from massive, dynamic, ambiguous and often conflicting data; detect the expected and discover the unexpected; provide timely, defensible, and understandable assessments; and communicate assessment effectively for action" (Page 4 of [21]).

Visual analytics is thus a multidisciplinary field that includes the following focus areas:

- Analytical reasoning techniques that let users obtain deep insights that directly support assessment, planning, and decision making;

- Visual representations and interaction techniques that exploit the human eye's broad bandwidth pathway into the mind to let users see, explore, and understand large amounts of information simultaneously;

- Data representations and transformations that convert all types of conflicting and dynamic data in ways that support visualization and analysis;

- Techniques to support production, presentation, and dissemination of analytical results to communicate information in the appropriate context to a variety of audiences.

Thus we can expect that visual analytics may significantly improve the Recognized Maritime Picture by offering cognitively rich representations, information filtering and clutter reduction capabilities, multimodal interactions and teamwork collaboration services, in order to provide better insight into information and increased situation awareness.

1.1.4   Related DRDC Projects

This contract builds on foundational work done by Defence Research and Development Canada (DRDC) in the following fields:

- Information visualization and management for enhanced domain awareness in maritime security (Project 11he).

- Collaborative Knowledge Exploitation for Maritime Domain Awareness (Project 11hg).

- Multi-hypothesis Link Analysis for Anomaly Detection in the Maritime Domain (Project 11hk).

1.1.5   Previous Work under ARP 11jm/11hm

This contract is part of a series that have been funded under DRDC's "Maritime Domain Analysis through Collaborative and Interactive Visualization" project ARP 11jm (previously 11hm), also known as Design of a Maritime Visual Analytics Prototype (DMVAP). Previous contracts under this project include:

- Literature and product survey [6, 8];

- MSOC (Marine Security Operations Centre) site visits and requirements analysis [5];

- Design study for the prototype [10];

- Architecture study for the prototype [2];

- Scenario descriptions and dataset requirements analysis [9];

- Reports on the development and testing of the core applications [12]

1.2   Project Objectives

The over-reaching objective of this project and this contract is:

a. Develop VA and collaborative technologies that help the Canadian Forces and MSOC personnel achieve their maritime surveillance mandate (Section 1.1.1).

Such technologies aim to achieve the following [18]:

b. Support rapid awareness and identification of key information elements and thus rapid insight into the meaning of a situation;

c. Improve the visualization of the recognized maritime picture;

d. Enable better comprehension of a situation and how it could develop;

e. Reveal what is not known (data gaps and uncertainty);

f. Support detection, alerting, and visualization of anomalies;

g. Enable collaborative team work.

In order for the technologies to address objective (a) the following project objectives were addressed, as described in Section 7:

h. Communicate to operational units the benefits of technologies developed in the project;

i.   Identify a mechanism to transition the technology from research to operational systems;

The specific objectives of this contract are (Annex A page 1 of [17]):

j. Design, develop, and test how the Phase 3 Maritime Visual Analytics Prototype (MVAP) supports Maritime Domain Awareness (MDA). This Phase 3 portion of the work follows on from Phases 1 and 2 that were documented previously [12];

k. Perform validation activities (usability trials) for all the visual apps and widgets of the MVAP to estimate how well objectives (b) though (g) have been met. Sections 2 through 6 of this document focus on the validation methodology and results.

The Oculus proposal [15] suggested that validation of the apps might address the following objectives, as discussed in Section 7:

l. Establish rigorous evidence that can be used to promote the MVAP approach to operational users, and thus facilitate transition of the technology to them.

m. Establish the relevance of MVAP technology to a wider set of users than the MSOCs and the RJOCs.

n. Extract scientifically rigorous observations suitable for publication in the scientific literature.

2 Methodology and Metrics

The MVAP apps developed in this project addressed operational objectives (b), (c), (d) and (f). Therefore Task 2, Prototype Apps Validation, focused on how well those four objectives were addressed in the apps. Section 2.1 outlines the software attributes that are important to achieve these objectives.

Sections 2.2 and 2.3 describe the selected validation methodology, which includes training, exercises, user juries, and structured interviews.

Section 2.4 identifies three types of metrics that will be used in the assessment, and Section 2.5 introduces the System Usability Scale questionnaires that were used.

2.1 Operational Performance Goals

The U.S. Department of Health & Human Services describes the impact to be expected from well-designed software [22]. Their description includes:

- Increased ease of use
- Increased ease of learning
- Increased user satisfaction
- Increased trust in the system
- Faster accomplishment of tasks
- Reduced number of user errors
- Reduced need for documentation

ISO 9641-10 [13] provides the following principles of good human-computer interaction:

- Suitability for the task
- Self–descriptiveness of the action
- Controllability
- Conformity with user expectations or consistency
- Error tolerance
- Suitability for learning.

ISO 9641-11 [13] similarly summarizes the attributes of good software as how well a product can be used to achieve specified goals, in a specified context of use (users, tasks, equipments and environments). Good software will achieve:

- Effectiveness (task completion by users)
- Efficiency (quickly and accurately)
- Satisfaction (good user experience)

O'Connell and Choong [14] also identify the following criteria for effective human-computer interactions:

- Responsiveness (e.g. immediate feedback)

- Minimal actions (i.e. interaction efficiency)

Scholtz [20] proposes that these lists must be extended for Visual Analytics software in a number of directions. Of most interest on this project is the suggestion that VA software should contribute to Situation Awareness, meaning it should help analysts:

- Perceive essential information

- Interpret it correctly

- Use it to predict what will happen next.

2.2   Methodology

The validation methodology was a User Jury and included: training of MSOC analysts, operational tasking within the context of a scenario, and assessment of software performance against the above performance goals. The full methodology can be summarized as follows:

1. **Planning:** An early onsite planning session was held on January 10th and 11th 2013 in Halifax. Nineteen MSOC analysts, representing the RCN, Coast Guard, RCMP, and CORA attended, watched a presentation of the MVAP developments, provided suggestions for the validation trials, and helped establish usability and operational performance goals.

2. **Experimental Design:** The validation methodology (this document) was developed by the Oculus team and reviewed by clients (DRDC) and operational staff. The methodology included:

    - Identification of validation metrics (see Section 2.3).

    - Definition of Operational Use Cases (see Section 4.1).

    - Development of appropriate datasets.

    - Design of a testing timeline, as shown in Figure 1.

    - Installation of MVAP apps on multiple workstations.

    - Observer training on-site before the trials (see Section 5.1).

3. **Participants:** Participants were all MSOC analysts, already familiar with the goals and challenges of Maritime Domain Awareness. Participants were separated into groups of up to 5 people, with each group spending approximately 45 minutes being trained, running the trial task, and providing feedback as discussed below.

4. **Participant Training:** Each group of participants was given 30 minutes of hands-on training by Oculus, as described in Section 3.

5. **Scenario-Based Exercise:** Each participant undertook an exercise that lasted about 15 minutes, to find information in the trial dataset using the MVAP apps and fill out the worksheet shown in Annex A, as described in Section 4. All participants were given the same exercise.

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6. **Observation:** MVAP team members observed the participants during training and during the exercise, taking notes using the Observer Form as discussed in Section 5.

7. **Subjective Reports:** At the end of the exercise, participants filled out an SUS Questionnaire (see Section 2.5 and Annex A) and a Ranking Survey. Scores were assigned and interpreted as described in Section 2.5.2.

8. **Hot Wash-Up:** After all participants had handed in their written notes, there was a brief "Hot wash-Up" discussion with all participants. Comments were noted by the observers.

9. **Synthesis:** The observations and surveys were assembled and interpreted as described in Section 6.
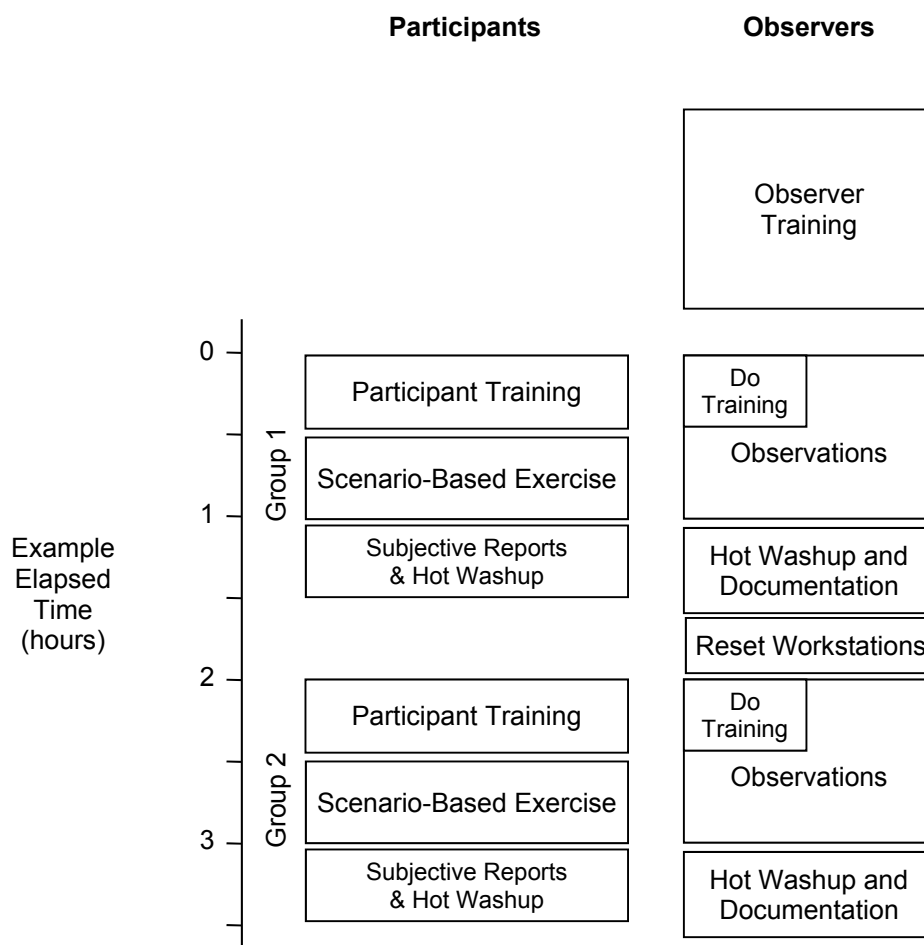
Figure 1: Timeline of the Methodology
Participants are trained for 30 minutes, then conduct an exercise for 30 minutes, then answer a questionnaire about the VMAP apps.

2.3 Participant Equipment

Participants were given the following equipment:

- MS Windows 7 laptop computer with network access to a common server.
- Google Chrome browser,
- A printed sheet describing the exercise assignment, with space for results to be documented, as described in Section 4.
- Blank assessment sheets, for usability assessment as described in Section 2.5.

All computers used the following resources on a shared server:

- Apache Tomcat server,
- MVAP software running on the server,
- PostgreSQL database, containing all training data and all exercise data.

2.4 Metrics

Four types of metric were collected for each participant:

- **Observations and Anecdotes:** Trial observers watched the participants, identified the type and number of non-critical errors made (e.g. false starts, requests for help, etc.) and recorded them on the Observer Worksheet in Annex A. Participants were also invited to record unstructured suggestions, and these were collected with the observer notes.
- **Time on Task:** An attempt was made to have the observers record the elapsed time for each task milestone [24] using the Observer Worksheets. After the first trial, the observers agreed that it was not possible to accurately estimate those times, so this initiative was abandoned.
- **App Ranking:** Participants ranked, on a scale of 0 to 2, how valuable each app would be if integrated into the domain awareness systems that they use.
- **System Usability Scale:** Participants provided their subjective assessments of the apps using the System Usability Scale questionnaires provided in Section 2.5.

2.5 System Usability Scale

The System Usability Scale was proposed by Brooke [3, 23] as a subjective assessment of usability that is general enough to be widely applicable across domains. Sauro [19] provides a helpful discussion of how to interpret SUS results.

Although the SUS questions do not directly address all of the performance goals in Section 2.1, we have avoided customizing them because:

- Brooke's standard list of questions is a universal benchmark for usability.
- The SUS list of 10 questions was created very carefully, by first generating 50 questions, running trials, and then down-selecting those questions where differing opinions emerged most clearly [4].

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- The questions are also arranged carefully, so that for example the positive statements such as "I liked…" are alternated with negative statements such as "I did not like …"

Annex A lists the SUS questionnaires for all the MVAP apps. Brooke provides a template for the SUS, and gives permission for it to be freely re-used on the condition that any resulting publications acknowledge its source (page 6 of [4]).

2.5.1 How the Questionnaires were Used

In accordance with Brooke's instructions [4], the questionnaires were used as follows:

- A SUS questionnaire was handed to each participant after the Scenario-Based Exercise, but before any debriefing or discussion took place.

- Participants were instructed to record their immediate response to each item, rather than thinking about items for a long time.

- Participants were instructed to insert a response for every item. If a respondent felt unable to respond to a particular item, they were to mark the centre point of the scale.

2.5.2 How the Questionnaires were Scored

Each questionnaire yielded a single number representing a composite measure of the overall usability of the app being studied. Scores for individual items on a questionnaire are not meaningful alone.

The SUS score for each questionnaire was calculated as described below, and as shown in Figure 2:

- The "scale position" for a question is the small number under the checked box.

- For odd-numbered questions (1, 3, 5, 7, and 9) calculate the score contribution as the scale position minus 1, and write that to the right of the scale.

- For even-numbered questions (2, 4, 6, 8, and 10) calculate the score contribution as 5 minus the scale position, and write that to the right of the scale.

- Confirm that all the score contributions range from 0 to 4.

- Add all the score contributions and then multiply by 2.5 to get an overall value that ranges from 0 to 100.

Based on statistics published by Sauro [19], the SUS results can be translated into a percentile values. A percentile value of 75%, for example, means that the MAP scored higher than 75% of the usability studies done by Sauro.

System Usability Survey

Mark one box in each row.

	Strongly disagree				Strongly agree	

1. I think that I would like to use these apps frequently — checkmark in box 4 — **3**
   - 1 2 3 4 5

2. I found the apps unnecessarily complex — checkmark in box 2 — **3**
   - 1 2 3 4 5

3. I thought the apps were easy to use — checkmark in box 3 — **2**
   - 1 2 3 4 5

4. I think that I would need the support of a technical person to be able to use these apps — checkmark in box 2 — **3**
   - 1 2 3 4 5

5. I found the various functions in these apps were well integrated — checkmark in box 5 — **4**
   - 1 2 3 4 5

6. I thought there was too much inconsistency in these apps — checkmark in box 3 — **2**
   - 1 2 3 4 5

7. I would imagine that most people would learn to use these apps very quickly — checkmark in box 4 — **3**
   - 1 2 3 4 5

8. I found the apps very cumbersome to use — checkmark in box 1 — **4**
   - 1 2 3 4 5

9. I felt very confident using these apps — checkmark in box 3 — **2**
   - 1 2 3 4 5

10. I needed to learn a lot of things before I could get going with these apps — checkmark in box 3 — **2**
    - 1 2 3 4 5

Sum = 28   Score = 2.5 x 28 = 70

Figure 2: Example scoring of a questionnaire

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3   Training the Participants

Oculus experts trained each group of participants as part of the software validation process, as shown in Figure 1. Time allocated for training was strictly limited to 30 minutes, and addressed each relevant MVAP app in turn, as described in Sections 3.1 through 3.6.

3.1   Analysis Set Manager

Time for this training: 5 minutes.

Procedure:

- Open a Chrome browser and go to the MVAP bookmark (`http://<server>:<port>/MVAP`)

- Click on the Analysis Set Manager

- Within the Analysis Set Manager, click the Add Group button and create a set called IRCS

  - Select set IRCS

  - Click Add Ship

  - Click "+" to add a search criterion

  - Specify that criterion as "Name", "Contains", "IRCS" and click "Search"

  - Toggle vessel selection by clicking on Vessels and "OK." This adds the vessels to set IRCS

- Right click on IRCS BAREU00 and remove the vessel from set IRCS

- Create another set called IRCS 6

- Cut and paste ship IRCS BATEU6 from IRCS to IRCS 6

3.2   Map and Timeline

Time for this training: 6 minutes.

- Click the Map button to launch the map and timeline for IRCS 6

  - Place the map cursor over Brussels and use the mouse wheel to zoom in

  - Place the cursor over the upper timeline and use the mouse wheel to zoom in

  - Click on the orange time window handles and drag them to enclose November 6th

  - Drag the white region on the timeline to animate around Nov6

  - Return to the Analysis Set Manager and delete both sets IRCS 6 and IRCS.

- Launch Map and Timeline with no set selected

  - Zoom the map to Halifax and the Bay of Fundy

  - Zoom the timeline to July 10-12 2011

- Click the Fetch Vessels button

- Animate vessel movement by dragging the white time region

- Mouse over vessels to see their names

- Select ship "Carrier" and observe that a Close Encounter pop-up appears

- Double click Carrier to see details then close the resulting window

- Click export and put all vessels in a new set called "Fundy ROI"

- Return to the analysis set manager and launch Record Browser then Magnets Grid on Fundy ROI

3.3   Record Browser

Time for this training: 5 minutes

- In the Analysis Set Manager, highlight the "Fundy ROI" set and then click on the "launch record browser" button

  - Observe the data items on each summary card: vessel image, NATO icon, Flag, 24h/96h indicators, VOI markers, word cloud.

  - Flip the card to see the expanded list of vessel properties.

  - Click on the grey bar to "select" a card and add it to the export button

  - Drag the card to the left to compare it to other cards.

  - Select a second card.

  - Click the "Add Analysis Set" button, name the new set, click "OK", and note that the new set is visible in the Analysis Set Manager

3.4   Magnets Grid

Time for this training: 5 minutes

- In the Analysis Set Manager, select "Fundy ROI" and launch the Magnets Grid app

  - Observe that vessels are represented as dots ("dust")

  - Click the "Shake" button to push dots apart randomly.

  - Mouse over a dot to see vessel information

- Create magnets for Vessel length, Speed, and Net Tonnage

  - Place the magnets and shake each one to see how the dust is attracted

- Click "Add Calculated Magnet"

  - In the Calculated Magnets dialog, specify a new magnet as "Country = Jacardia"

  - Place the new magnet, shake it, and observe three ships "Carrier", "CarpeDiem", and "Gigaloo" are drawn toward that magnet

- ◆ Use marquee drag to select those three ships, then export them as a new Analysis Set called "Fundy VOI"

3.5   Timeline

Time for this training: 3 minutes

- In the Analysis Set Manager, select "Fundy VOI" and launch the Timeline app
- Use the timeline to visualize events for these three ships.
- Double-click on a name-change event to synchronize multiple timelines.
- Split Gigaloo and compare Jun 12 to May 1.

3.6   GPW Map and Timeline

Time for this training: 4 minutes

- Explain how GPW Map and Timeline differs from Map and Timeline
- Launch the GPW Map and Timeline
  - ◆ Zoom in on Sable Island
  - ◆ Zoom timeline to January 1,2012 00:00-03:00
  - ◆ Fetch all vessels near Sable Island
  - ◆ Select ship "Panuke Sea", get compressed tracks, and encounters
  - ◆ Follow the Panuke Sea track to find an encounter south of St. John's
  - ◆ Animate the interaction by sliding the time slider.

4 Scenario-Based Exercise

If the Training session (Section 3) achieved its ambitious timeline, two minutes remained to instruct the participants in the Scenario-Based Exercise, and then 15 minutes for them to complete that exercise. The exercise proceeded as follows:

- Participants and observers checked that their computers were in an acceptable state for the exercise

- Oculus then assigned the exercise as described in Section 4.1

- Participants were given a worksheet (Annex B) that included:

  - A summary of the assigned exercise.

  - A set of fill-in-the-blank questions to be answered during the exercise.

- Observers watched how the participants used the MVAP software to achieve the exercise goals, as described in Section 5

  - If participants asked "how to" questions, the observers answered them verbally but did not touch the computers. Such events were recorded by the observers.

- When all participants had achieved the objectives (usually after about 15 minutes) Oculus collected the worksheets and handed out the "Ranking" sheets for the observers to fill out.

4.1 Scenario for the Exercise

- Intercepted signals suggest that a person of interest (Mr X) was on or near the Bahamas on April 1st, 2012.

  - Task 1: use the GPW to find all vessels near the Bahamas on that day.

- A signal from a different person of interest (POI 2) was intercepted around that time that included the word "Carnival." Intelligence analysts suspect a possible collaboration between Mr X and POI 2, and hence need to know what ships with that name were at or near the Bahamas on that day.

  - Task 2: find the track of such a vessel whose name includes the word "Carnival."

- If Mr X was on a Carnival ship, we are interested in knowing the next port of call of that ship, arrival time, and route.

  - Task 3: Animate the track of the selected vessel to find their next port of call and time of arrival, and to determine if the route was direct or indirect.

  - Task 4: Export the vessels and tracks to the MVAP, and create a "Carnival" analysis set.

    - Note: for the actual trial, there was no internet connectivity. Thus, it would not have been possible to retrieve vessel images and meta data from the internet. So, the vessels were exported prior to the trial and stored in the database. During the trial, users simply opened the analysis set manager and searched for vessels named Carnival.

- Information indicates Mr X may be on one of the newer, larger Carnival ships, we need to characterize the tonnage and build year of each vessel.

  - Task 5: Use the Magnets Grid to characterize the ships using a combination of Build Year and Net Tonnage.

- The vessel of interest is flying under a Panamanian flag.

  - Task 6: Use the Record Browser to compare the ship flags.

5 Procedures for Observers

The role of the observers was to notice and record behaviours of the participants that revealed software flaws and software strengths.

5.1 Preparation

Observers received two types of training:

- **MVAP Training:** in order to recognize how participants are interacting with the apps, the observers first gained familiarity with the apps. This was required, for example, in case a participant used MVAP in an unexpected way - an untrained observer might mark this as an error, whereas a trained observer might recognize that the participant has found a better strategy. This requirement was addressed by having the observers first execute the usability trials, on the morning of the experiments, as shown in the Figure 1 timeline.

- **Usability Evidence Training:** observers were taught how to observe user behaviours and evidence for usability, and how to recognize events of interest, using guidelines from the literature as described in Section 5.2.

5.2 Observing Participants during Training and Tasked Activities

Observer used one worksheet (see Annex A) for each participant to record relevant actions and events as the participants learned to use the MVAP apps and as they used the apps to tackle the assigned tasks. An attempt was made to record the elapsed time for each assigned task, but these values were deemed unreliable and hence were not used. The observers watched for the following specific types of actions and events:

- **Critical Errors:** Critical errors are deviations that prevent the participant from finishing a task. Participants may or may not be aware that the task goal is incorrect or incomplete. [24]

- **Non-Critical Errors:** Non-critical errors are errors that are recovered by the participant and do not block the successful completion of the task. These errors result in the task being completed less efficiently. For example, exploratory behaviors such as opening the wrong navigation menu item or using a control incorrectly are non-critical errors. [24]

- **Unanticipated Strategies:** Participants may discover ways to use the apps that were not anticipated during the design process. Such observations are helpful because they identify previously unrecognized app capabilities that may benefit from further development.

- **Self-Learning:** Observers may observe participants initially failing to solve a problem, and then organically discovering (i.e. without being taught) the capability of the apps. Such observations are helpful because they identify strengths in the apps that need to be protected.

5.3   Hot Wash-Ups

The observers led the Hot Wash-Up discussions and recorded all the responses and comments made by the participants.

6   Detailed Assessment of Results

Sixteen MSOC analysts and specialists, in four groups, participated in user trials November 13th and 14th 2013 in Halifax. Analyst affiliations included:

- Royal Canadian Navy
- RCMP
- Transport Canada
- Canadian Border Services Agency
- Department of Fisheries and Oceans
- Coast Guard

The trials were conducted as described in Sections 3 through 5. Annex B contains the raw hand-written notes from these sessions.

The comments and observations from these trials are reported and analysed in the following subsections. Tables 1 through 6 list every received comment, cross-referenced to Annex B. Where many similar comments were received, a single summary is recorded in the table but cross-references are provided to all the original written comments. Thus the presence of multiple cross-references is evidence that an opinion was widely held among the participants.

All the observers attended the same Hot Washup meetings, so there is a lot of overlap in their reports of those meetings. When a Hot Washup comment is inserted into a table, only one cross-reference is provided because only one comment was made, even if that comment was reported by multiple observers.

6.1   Overall Assessment of the MVAP

Table 1 encapsulates comments about the MVAP as a whole, including System Usability Survey (SUS) results. The SUS results averaged 76/100, which is better than 75% of new software systems [19]. Figure 3 shows average scores for each SUS topic. Table 8 in Bangor *et al* [1] shows that 76/100 corresponds to a rating of "Excellent" which is the second-highest rating on their scale. Participants in the comments used words similar to "excellent" to describe the MVAP apps.

Written comments from the participants were similarly positive, suggesting that MVAP capability would be a valued asset and certainly a step-up from the systems currently being used at the MSOC. A number of commenters encouraged us to explore using MVAP more widely than the MSOC.

Recommendations from Table 1can be summarized as follows (in no particular order):

a. Deploy MVAP to the MSOC as soon as possible

b. Find a way to also deploy MVAP for operations that are isolated from the MSOC databases

c. Extend MVAP to read and write a wider variety of file formats and types, including Alerts

d. Provide the ability to save an MVAP session to file for sharing or later resumption of analysis in context
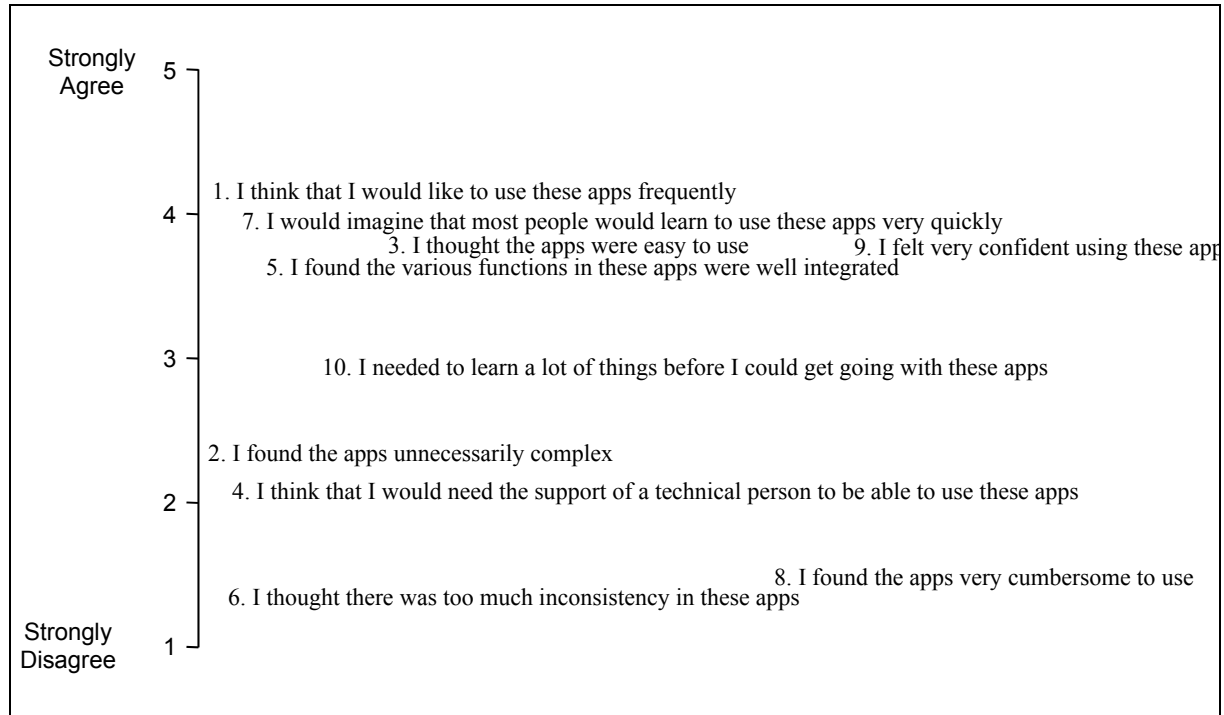
Figure 3 Average Scores on the Ten SUS Survey Questions
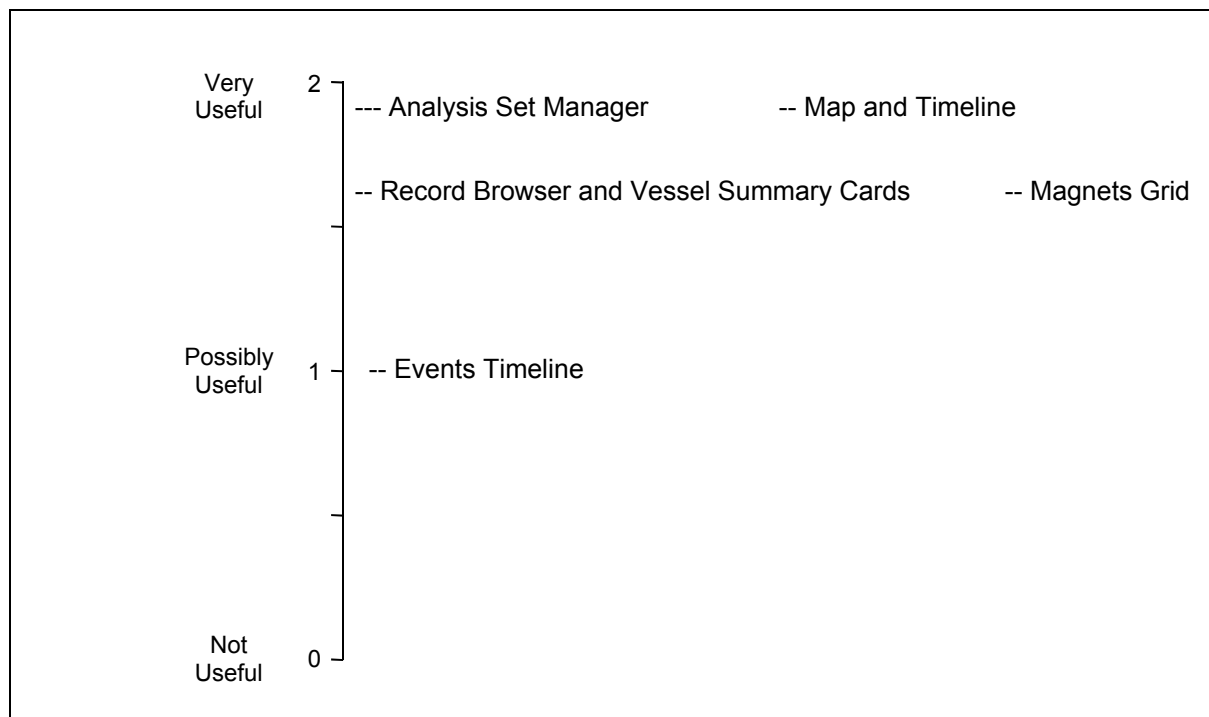
Figure 4 Average Ranking of the Five Apps

Table 1 Comments and Observations about MVAP in General

Maritime Visual Analytics Prototype
System Usability Survey (SUS):   • Number of SUS surveys handed in: 14   • Scores: average = 76, median = 79, lowest = 40, highest = 92   • Percentile: MVAP scored better than 75% of new software releases (using statistics from [19])
Positive Comments not Specific to an App: MVAP had Immediate Appeal: • The "buzz on the street" is that MVAP is pretty cool [C.1.4.1a]   • Between other systems or MVAP, this is the best [C.3.2.4a]   • Very useful – can't wait to use it, when do we get it? [C.2.3.2d, C.3.4.1b, C.3.1.4a]   • This is a tool that an analyst would use. [C.3.2.1a]   GUI was Intuitive: • GUI was intuitive so participants were trying features without waiting for training [C.1.1.4h]   MVAP would Add Value in Various Contexts: • All apps represent concepts that would greatly improve the visual analysis [C.2.4.2a, C.3.4.1d]   • We would be interested in using this tool isolated from the big databases [C.3.3.3k]   • This should be in MSOC, not just the RCN watch floor [C.3.2.3c]   • This would be useful for link analysis [C.3.4.1a]
Negative Comments not Specific to an App: • There were bugs apparent when trying to Drag and Drop [C.2.1.2f]   • Integration between the apps should be improved [C.2.4.2b, C.3.4.1e, 3.4.2d]
Suggestions for the Future: • Need more time to evaluate these apps properly [C.2.2.5a]   Improve the GUI: • Support "right-clicking" on visual elements to get a listing of options [C.2.3.2b]   • Provide MVAP as a toolbox on the analyst dashboard, where each tool can clicked when needed [C.3.2.3f]   Improve data sharing: • Support import of other formats of data, including alert results [C.1.3.1a, C.1.1.4b, C.3.1.1n, C.3.3.3j]   • Export analysis results to Greenline or Google Earth and add pretty labels [C.3.2.3b, C.3.2.3n, C.3.3.2g]   Support session endurance and sharing: • Provide metadata so that the inferred "analysis story" is traceable [C.3.1.1k]   • Add the ability to save a working session, share with collaborators, or come back to it at a later time [C.3.2.3a]

6.2   Assessment of the Analysis Set Manager

Table 2 presents comments that were specifically about the Analysis Set Manager (ASM). On the Participant Ranking Sheets (see Annex A) where the scale ranges from 0 "not useful" to 2 "very useful", the average ranking of the Analysis Set Manager was 1.9.

Feedback from participants was positive, and included suggestions for streamlining the user interface. Participants were quick to understand the ASM and start using it to create manageable groups ("analysis sets") of contacts. Initial problems with the user interface were rare and can be attributed to the learning curve rather than design flaws. The collected observations may however point to simple GUI improvements that would make the ASM more accessible. As stated in Section 6.1, participants were keen to extend the ASM to read a write a wider range of data formats and to share analysis sets with other analysts.

Not only did participants embrace the ASM's key role of structuring analysis data, they were keen to extend and enhance it. They recommended that work be done to define better analysis set hierarchies for operational analysts to use with the ASM.

Recommendations from Table 2 can thus be summarized as follows (in no particular order):

e.   Extend ASM to read and write a wider variety of file formats and types, including Alerts.

f.   Tweak the ASM GUI to improve navigation, selecting ships and setting up a search.

g.   Define a deeper structure for the analysis sets, and provide the ability to save ASM sets for sharing or for later resumption of analysis.

Table 2 Comments and Observations about the Analysis Set Manager

Analysis Set Manager
Average User Ranking: 1.9
Positive Comments: • Clear and easy to understand [C.2.3.3a, C.2.3.1a, C.2.4.3a • Great for grouping certain datasets [C.2.1.3a, C.2.1.2a
Evidence of Self-Learning: • (None reported)
Suggested New Ways to Use This App: • Export sets to Excel (the app already supports this) [C.3.3.3n]
Noted Bugs or Criticisms: • Clicking MVAP shortcut does not take you back to the Analysis Set Manager (have to click ASM button) [C.1.4.3b] • Creating folders, and adding to them, is non-trivial [C.1.2.1b]
Observed Errors When Learning: Problems setting up a search: • Clicked "OK" rather than "Search" to get the list [C.1.2.4d, C.1.3.1b , C.1.3.2a, C.1.1.1a , C.1.1.1.f] • Search did not work using filter "carnival" instead of "Carnival" [C.1.3.4g] Problems selecting a sub-list of ships: • Opened the Record Browser with only one ship instead of a group [C.1.2.4f, C.1.2.4h] • Used "shift-click" to select the vessels [C.1.4.3a] • Tried clicking the first in the Analysis Set, then shift-clicking the last, to "Select All" [C.1.1.1a] • After a search created a short-list, did not select the desired vessels, just clicked "OK" [C.1.1.3f]
Suggested Improvements or Added Features: Improve data sharing: • Ability to share analysis sets between analysts or with other systems (e.g. Greenline) [C.2.1.1a, C.1.2.1a, C.1.2.3c, C.3.1.3k, C.3.2.3m] • Ability to import a vessel set from a non-MSOC source or a VMS pull from a fisheries analysis [C.1.3.1a, 3.1.4o] • Export the analysis context so that other analysts can go there. [C.3.1.3k] Add deeper structure to the analysis sets: • Save analysis sets in a relevant directory structure [C.3.1.3k] • Each problem is different so we need a flexible analysis set hierarchy encoded as directories or groups – like a recipe [C.3.1.4n] Improve the GUI: • Provide more efficient method to select multiple ships (use standardized GUI method) rather than having to select each ship [C.2.1.4a, C.2.3.2a]

6.3　Assessment of the Record Browser and Vessel Summary Cards

Table 3 presents the comments that were specifically about the Record Browser and Vessel Summary Cards. On the Participant Ranking Sheets (see Annex A) the average ranking was 1.7.

There were two major concerns with the Record Browser and Vessel Summary Cards:

- Two participants mentioned that software is already available to provide a similar visualization.

- The visualization is highly dependent on having a rich field of "tombstone" facts to place on the back of the card, and detailed dynamic information (e.g. recent ports visited) to place on the front of the card.

There were also a number of good suggestions about how to improve the Record Browser and Vessel Summary Cards, as shown in Table 3. Key recommendations are (in no particular order):

h. People immediately understood the Vessel Summary Card concept and wanted to extend it to be configurable for each analysis focus.

i. If there are existing apps at the MSOC that provide a similar Record Browser functionality, work should be done to clarify the role of the Record Browser when integrated with those existing apps.

j. Connect the vessel summary cards ("Vessel Summary cards") "live" to the database so that they update as new information becomes available.

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Table 3 Comments and Observations about the Record Browser and Vessel Summary Cards

Record Browser and Vessel Summary Cards

Average User Ranking: 1.7

Positive Comments:
- "Vessel Summary Card" concept is useful and easy to understand [C.2.3.3b, C.1.1.3c, C.2.1.3b]
- The Word Cloud of most-visited ports is good [C.2.4.3b]

Evidence of Self-Learning:
- Opened the Record Browser without a set selected, then figured out what the problem was, went back at selected a set as required. [C.1.3.3a]
- When the graphic national flag was not recognized, flipped the card to read the country name [C.1.1.1h]
- Intuitively dragged a card to the left display position, before being taught this [C.1.4.3c]

Suggested New Ways to Use This App:
- This will be good for the Watches [C.2.1.4b]

Noted Bugs or Criticisms:
- This capability is easily available in other software [C.2.3.1b, C.2.4.3b]
- Online data (used for the prototype Vessel Summary Cards) is often out of date [C.2.1.2b]

Problems with the GUI:
- Drag-and-drop error (?) caused two transparent cards to overlay each other in the browser [C.1.2.3f, C.1.2.5b, C.1.1.4j, C.3.1.2a]
- The user tried to put the left card back into the deck. [C.1.1.1.d]
- Cumbersome [C.2.1.3b]

Observed Errors When Learning:
- Tried to mouse-over the flag to see the country name pop up, and did not think of flipping card [C.1.2.3i, C.1.2.5e, C.1.1.4, C.1.1.4m]
- Double-clicked on the analysis set and got only a single card [C.1.1.4d]

Suggested Improvements or Added Features:

Show richer information fields:
- Allow the user to configure the Vessel Summary Card contents [C.2.1.1b, C.3.1.3j]
- The card should update automatically as the underlying data changes [C.2.1.2b, C.1.1.3a]
- Vessel Summary Card should show the most recent port [C.1.2.4b]

Reveal information more clearly:
- Provide a legend or tooltips to explain the info shown on the cards [C.2.4.1a]
- Make is possible to see top and flip-side of a Vessel Summary Card at the same time [C.1.2.5a]

6.4   Assessment of Magnets Grid

Table 4 presents the comments that were specifically about the Magnets Grid app. On the Participant Ranking Sheets (see Annex A) Magnets Grid scored an average ranking of 1.7.

Magnets Grid created a significant "buzz" among the participants, apparently because of its novelty, its apparent "abstract" visualization strategy, and its very quick learning curve. Comments such as "awesome" were quite common. Some participants found the prototype very interesting but could not see how it would be useful to them, in part because it is most useful when there is a rich array of operationally-relevant data for every vessel, and they did not expect to have such data available.

There were some good suggestions about how to improve Magnets Grid. Some of these are just small bugs and are listed in Table 4 but the following recommendations merit more careful attention:

k. Magnets Grid is surprisingly simple to use (surprising because it is difficult to explain verbally, but easy to understand when implemented) and provides uniquely valuable insights. It should be used in the MSOCs for comparing vessels, multi-parameter searching, and fuzzy analysis.

l. The ability to create new rules and associate them with magnets is very good, but the software should make that process more efficient and user friendly, for example by using more pull-down menus to select data fields.

m. The Magnets Grid concept should be linked to MSOC's trip wires, choke points, and regions of interest. Thus for example "hours since entering Cabot Straight" might be assigned to a magnet.

Table 4 Comments and Observations About the Magnets Grid

Magnets Grid
Average User Ranking: 1.7
Positive Comments: • Interesting / awesome representation [C.2.3.1c, C.2.4.3c, C1.3.4c, C.3.3.3g, C.3.2.1d] • Very useful [C.2.1.1c, C.2.2.2a, C.2.2.4a, C.2.4.1b, C.3.1.3d, 3.2.3m] • Like how you can drag and select and export to an analysis set. [C.2.1.2c, C.3.3.3i] • Much better than reviewing text attributes line-by-line [C.3.2.3d]
Evidence of Self-Learning: • Figured out how to select a group of ships and then export them as an Analysis Set [C.1.2.5g] • Tried out various magnet arrangements and explained what the patterns meant [C.1.2.5h]
Suggested New Ways to Use This App: • Use this to compare vessels [C.2.4.3c] • Look for newer builds, flag, country of registry [C.3.3.3g] • Quite practical for "fuzzy analysis" [C.2.1.4c] • To view discrete events, associate the event types with the colour of the dots [C.3.3.3h]
Noted Bugs or Criticisms: • Usefulness depends on getting access to the data [C.2.1.1d, C.2.1.4c, C.3.1.4f] • Not sure when I would use this [C.2.1.3c, C.2.3.1c] Conceptually Difficult: • Not clear what the arrows mean [C.3.2.3q] Software Bugs: • The app exported "all" instead of just what was selected.[C.1.1.1.e] • It is difficult to shake the magnets [C.1.1.1i] • Accidently got a blue "select" square and could not make it go away [C.1.1.4k, C.3.3.1a] Outliers may Dominate: • When one vessel is an outlier, all the others stay tightly clustered ("Panuke Sea problem") [C.3.3.2a]
Observed Errors When Learning: • Selected "Length" magnet rather than "tonnage" [C.1.2.4g] • Double clicked from Magnets Grid (MG) and lost MG context and did not see that a new tab was created [C.1.2.4i] • Opened two ships, found in MG, directly to individual cards rather than to an analysis set [C.1.3.2c] • When exporting selected vessels, did not click the Radio Button [C.1.1.4e]
Suggested Improvements or Added Features: • Explain what it means to have a magnet representing an address [C.1.3.4d] • When defining magnets, provide pull-downs on record fields, so you don't have to remember the names [C.3.1.3e] • Provide Magnets Grid calculators that use geographic measures such as trip wires, choke points, Regions of Interest (ROIs), boundary area [C.3.2.3o]

6.5   Assessment of Map and Timeline

Table 5 presents the comments that were specifically about the Map and Timeline app. On the Participant Ranking Sheets (see Annex A) Map and Timeline achieved an average ranking of 1.9.

The Map and Timeline app generated so much interest that Table 5 is more than twice as large as the other tables in this Section. A number of people said that this is the best app of the MVAP suite, and much better than other systems available to them for viewing vessel behaviour. Participants were particularly excited about the GPW Map and Timeline, which uses real data and can be used to report on close encounters. Participants went beyond our suggested applications to suggest that the app could be used to characterize what is normal (i.e. "baseline activity") and to communicate analytical results more clearly (as a video) when giving a briefing.

The ability to slide backward and forward in time was very popular but participants found the time slider user interface difficult to master. Thirteen separate references in Table 5 were directed at this problem. When it was suggested that this might just be a learning curve issue, an MSOC leader underscored that learning curves are to be avoided if possible because of the high turn-over in manpower at the MSOCs. Participants suggested some relatively easy solutions, such as double-clicking on the timeline to specify a desired time, or providing a simple pop-up query box.

Given the high value accorded to the Map and Timeline information, the participants wanted more tools to help access that data efficiently. Specific recommendations include:

n.   Map and Timeline is excellent and important: deploy it soon as a primary domain awareness tool

o.   Deploy an initial version of Close Encounters, and then continue to improve it as noted in Table 5

p.   Improve the timeline:

- Provide more standard interactions (e.g. type in the start and end date and time)

- Make the graphic timeline more user-friendly and robust (e.g. provide tooltips and improve robustness).

q.   Improve the robustness of the track animation:

- Prevent situations where the slider can be moved without causing the tracks to animate.

r.   Add more features to the Close Encounters tool:

- Provide a flexible temporal and spatial search box

- Support the use of double-click on a close encounter event to jump both the timeline and the map to that event

- Estimate the probability that a close encounter was not an accident

- Export the list of close encounters

Table 5 Comments and Observations About the Map and Timeline

Map and Timeline
Average User Ranking: 1.9

Positive Comments:

- This is the best app of all [C.2.1.2d, C.2.2.2a, C.3.2.3g]
- Very good representation [C.2.3.1d]
- Much better than other systems where it is almost impossible to detect a close encounter [C.3.4.1c]
- Timeline GUI is good for fine-grain adjustments when zoomed in [C.2.4.1c]

The app is useful:

- Like visualizing time evolution [C.2.1.2d, C.2.1.3d, C.2.3.3c]
- Like visualizing multiple vessels interacting [C.2.3.1d, C.3.3.3d, C.3.3.2d, C.3.4.1c]
- Like seeing encounter icons directly on the map [C.3.1.1a]
- Like being able to search for events (e.g. close encounters) [C.3.1.3b]
- Like being able to communicate vessel tracks [C.2.3.3c]

The app uses real data:

- Like this app if it will handle large data [C.3.1.3a]
- Like how you can import tracks (e.g. Vessel Management System / Fishing) as spreadsheets [C.3.1.3m]

Evidence of Self-Learning:

- Found the small track bars in the lower timeline [C.1.2.5f]
- Figured out how to animate on the map using one handle of the timeline [C.1.1.1g]
- Tried using other tools to find Carnival ships [C.1.1.4i]

Suggested New Ways to Use This App:

Use it for visualizing motion:

- Useful for pattern-of-life analysis and determining baseline activity [C.2.4.3d]
- When analysing a "play," use the timeline to animate the story, then hit a button to "play". [C.3.3.3b]
- Use the sliding timelines to detect polluters [3.2.3r]
- For example: start with a set of 50 fishing vessels, ask what planes flew over them, ask the same question to another agency, then bring back all that you learned and put it in the tool. [C.3.1.1j]

Use it for close encounters detection:

- Search for close encounters should be done in two ways: a) "who encountered ship N?" and b) "of all ships within a Region of Interest, where did close encounters occur?" [C.3.1.3c, C.3.1.4b]
- Automate the very complex analytical process at the MSOC of detecting close encounters [C.2.4.3f]

Noted Bugs or Criticisms:

The Timeline interface was difficult to learn:

- Timeline Bar is difficult to use [C.2.1.4d, C.2.1.3d, C.1.3.2b, C.1.2.4j, C.3.1.3f, C.3.2.3f, C.3.4.1k]
- Can't easily tell what year it is [C.1.1.2a, C.1.1.3g]
- Sometimes it aligns with the date on the left wall of the window, so when you zoom, the desired date goes out of view [C.1.1.1b]
- If the white area in the timeline is too wide there may be no way to regain control of the slider. [C.2.4.1c, C.1.3.4e, C.3.1.3i]
- Tools should be immediately intuitive to avoid the need for a learning curve because there are many analysts coming and going [C.3.1.3h]

It was difficult to animate some tracks:

- It is difficult to animate the tracks [C.1.3.4e, C.3.1.3i]
- If the white area in the timeline is too wide, or if the tracks end within the time interval, the tracks no longer animate [C.1.1.1c, C.1.1.2d, C.1.3.4e, C.3.1.3i]
- Time line slider is jumpy when looking at Panuke [C.1.2.5c]

There was some difficulty fetching, searching, selecting, and exporting ships using this app:

- Not clear which contacts are fetched (all within the go area and time window?) [C.1.1.2b]
- Need a better way to search for vessels ("search button") [C.1.2.3d, C.1.1.4a]
- Having to select vessels one at a time is slow [C.1.2.3d, C.1.1.2e]
- Not clear whether we can export, to the Analysis Set, a subset of ships visible in the Map and Timeline, or whether we have to export all [C.1.3.4b]
- Problems dragging a vessel into the Vessel Summary Card Browser [C.1.1.2h]

There was some confusion between the Map and Timeline and the GPW viewer:

- Not clear whether to use Map and Timeline or GPW [C.1.1.2c]
- The app runs slow on the test platform and thus was difficult to evaluate [C.2.2.5a]

The appearance of the app could be improved:

- It's hard to see the light blue tracks against the grey background [C.1.3.4a]
- When you fetch "encounters" (which takes a long time) the GUI freezes – should have "busy" signal [C.1.1.3b]
- Not clear what Close Encounters plot shows [C.1.4.4a]

Observed Errors When Learning:

Errors using the Timeline:

- Problems zooming and panning on the timeline [C.1.2.1c, C.1.2.4e, C.1.3.1c, C.1.1.4c, C.1.1.4b]
- Selected the wrong year and then the vessel search did not work [C.1.2.4f, C.1.4.1b]
- When trying to go to a future port, participant scrolled backwards in time [C.1.2.3g]
- Trouble finding date- time when ship is in port (needed to animate the ship to port, then mouse-over) [C.1.2.3.h]

Errors extracting subsets:

- Trouble creating an Analysis Set from selected vessels [C.1.1.2g]
- Tried to select all the Carnival ships at once, in the map view [C.1.2.5d, C.1.3.4h, C.1.1.2f]
- Confused between general "fetch tracks" and "compressed tracks" using time boundary [C.1.1.1i]

Difficulties with GPW:

- Accidently made a GPW query that took a long time [C.1.1.4fg, C.1.4.1c]
- Gave up after a long delay and hit "cancel" on GPW Fetch [C.1.1.3e]

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Suggested Improvements or Added Features:

Improve the Timeline:

- Provide an alternative where you type in dates rather than scroll the slider [C.2.3.2c, C.3.1.3h, C.3.3.3a, C.3.2.3h, C.3.2.3i, C.2.1.1f]
- For example double-click to enter a date to snap to [C.3.4.2g]
- Maybe use a calendar pop-up to select the time window [C.3.2.3j]
- Double-click on the timeline to go to that date [C.1.2.4a
- Use iPhone-like time selector: scroll up on dials to define the time [C.3.1.3g]

Improve the visual appearance:

- Provide better maps and map perspectives [C.2.1.1e, C.3.3.3m]

Improve the Close Encounters interface:

- Double-click on a track in the Close Encounters window to auto-zoom to the time of close encounter and to the other ship [C.1.2.3a, C.1.2.4c
- Allow users to configure the spatial and temporal width of the close-encounters box [C.3.2.2a, C.3.3.2h, C.3.4.1f]
- Create a textual list of all detected Close Encounters [C.3.4.1i]
- Can we assign a "probability of close encounter" as a percentage? For example if a ship stops, that increases the chances it was a close encounter [C.3.4.1j]

Improve selection of ship subsets:

- "Select All" visible ships, then export them as an Analysis Set to be searched by attribute [C.1.3.4f, C.1.1.2f, C.3.4.1e]
- Provide a search-on-feature capability to select ships on the map [C.3.4.1g]

Provide enhanced output products:

- Export an animated track as a video, perhaps to play in a separate widget [C.3.3.3c, C.3.3.2c]

6.6   Assessment of the Events Timeline

Table 6 presents the comments that were specifically about the Events Timeline app. On the Participant Ranking Sheets (see Annex A) this app scored an average ranking of 1.5, which is the lowest score of the five apps tested. This app was taught last, when time was tight, and it was not required for the challenge tasks, which may explain this low score.

The Events Timeline uses a timeline with similar controls to the Map and Timeline app, and thus suffered from some of the same learning-curve issues. Developers should ensure that the Events Timeline inherits similar improvements that are made for the Map and Timeline GUI.

The following themes emerged from the comments:

s.   The app highlights the need to analyse temporal patterns, something that is not done much. and offers tools for doing that,

t.   Participants would like to use this with trip-wire, choke point, and region of interest events.

Table 6 Comments and Observations About the Events Timeline

Events Timeline
Average User Ranking: 1.5
Positive Comments: • Great for comparing tracks of the same vessel [C.2.1.3e, C.2.3.1e, C.2.4.3e] • Temporal representation is a topic we need to become accustomed to using [2.2.1.1g] • Very good representation [C.2.3.1e, C.1.2.3b, C.3.3.3a] • Liked multi-timelines with ability to unlock and shift them [C.3.3.3e]
Evidence of Self-Learning: • Figured out how to remove a split timeline [C.1.1.2j] • Had good skill with the timeline [C.1.4.2a]
Suggested New Ways to Use This App: • Synchronize on arrival at a specific port then look at previous ports of call [C.3.3.3f] • Compare tracks of the same vessel over multiple voyages [C.2.1.3e, C.2.3.1e, C.2.4.3e] • Useful for investigating close encounters and fleet activity [C.2.4.3e] • Feed trip-wire events or other "alerts" into the app [C.3.2.3p, C.3.1.4p]
Noted Bugs or Criticisms: • Not very intuitive [C.2.2.1.1g] • Not applicable to my position [C.2.3.3d]
Observed Errors When Learning: • (none reported)
Suggested Improvements or Added Features:

- Provide a legend explaining what the icons mean [C.2.1.4e]
- Type in dates rather than scroll the slider [C.2.3.2c]

7 The Route Forward

The results of these trials should be influential in identifying the next step forward to make these visual analytics tools and concepts operationally available to the CF and the MSOC.As summarized in Section 6, comments from the trial participants are very positive, but to achieve this potential operational migration, foundations must first be laid as discussed in Section 7.1.

7.1 Steps required Before an Eventual Operational Deployment at the MSOCs

The MSOC user community is keen to start using MVAP soon, as evidenced by comments such as the following from Table 1:

- "Between other systems or MVAP, this is the best"

- "Very useful – can't wait to use it, when do we get it?"

- "This is a tool that an analyst would use."

This section briefly reviews what has to be done to achieve this.

There are many challenges associated with raising a prototype such as the MVAP to operational status, but the MVAP architecture was chosen to make the transition less difficult. DRDC and Salience decided in an early design study that MVAP would be a set of apps rather than an integrated system solution [10]. It was clear at the time that the target users – the naval RJOCs and the multi-agency MSOCs – would never fund the development of a new integrated system solution just to gain visual analytics technology. MVAP was thus envisioned as an ensemble of loosely-integrated apps that could be attached onto an existing system as value-added modules.

To maintain this value-added app approach, DRDC and Oculus implemented the apps using a Service Oriented Architecture with code written in JavaScript and Java, and libraries such as Google Web Toolkit, jQuery, and Oculus's *Aperture* [12]. This means that the prototype can be run on a generic browser as long as appropriate web services are in place to serve up the operational datasets. The technical challenges of connecting the MVAP widgets to MSOC's operational data are therefore readily achievable.

The following tasks will be required:

- **Characterize the MSOC IT Context:** Acquire or create a detailed specification of how the MVAP apps will connect into the MSOC systems. MSOC systems were characterized at the beginning of the MVAP development [5, 7] but that analysis needs to be updated because major changes have occurred at the MSOCs since then. Work will include:

  - Create a list of all interfaces that can and should be used by the MVAP when it is installed in the MSOC.

  - Collect the specifications for those interfaces, either by reading existing documents or by visiting the MSOC and creating a new document.

- Identify current MSOC analysis tasks that would be affected by the MVAP apps, and characterize their objectives, data quality, work flows, etc. Clarify exactly what products each MVAP app should produce in order for those products to integrate easily.

- Identify data firewalls within the MSOCs that will constrain MVAP's connectivity.

- Determine what accreditation process will be required by MSOC IT management before they will allow the installation of apps.

- **Specify Essential Modifications:** based on the above description of the operational context, plus lessons learned in these trials, specify all *essential* MVAP modifications. These are expected to include:

  - Support for new interfaces between MVAP and the MSOC systems.

  - Ability to work in a dynamic information space where contact information is constantly being added.

  - Modifications to MSOC components that are external to the MVAP apps (e.g. adding a new table to an MSOC database, or adding a new service to an MSOC data stream).

- **Prioritize and Select Optional Improvements:** create a prioritized list of non-essential but desirable improvements to the MVAP apps:

  - Based on the November 2013 trial results and on information collected from the MSOCs, create a list of optional MVAP improvements and rank them by cost and benefit.

- **Develop an integration plan:**

  - Create formal plans for implementing, validating, installing, and integrating the MVAP apps

  - Validate the plans with the scientific authority and with the MSOC agencies.

- **Implement Selected Software Improvements:**

  - Write the new software.

  - Test the software as much as possible in a simulated environment.

- **Install, Validate, Train, and Support**

  - Install, test, and validate the software in the MSOC. The initial connection would be one-way, so that errors made in the MVAP apps do not trickle down to the MSOC.

  - Train MSOC operators on the MVAP (with the one-way data feed), assess their abilities, assess the reliability of the MVAP elements, and determine whether MVAP is ready to go live.

  - "Go live" by connecting MVAP output products into the MSOC data stream.

  - Provide long-term software support.

8   Summary and Conclusion

Phase Three of the Maritime Visual Analytics Prototype (MVAP) contract has been successfully completed. This document is the Final Report for Task 2, Prototype Apps Validation

The objectives of the validation trials were to:

- Collect objective evidence about the value of the MVAP apps to support rapid situation awareness, visualization of the recognized maritime picture, anomaly detection, and collaboration.

- Identify how the apps could be improved to better match end-user requirements.

- Take an initial step toward installing the MVAP in an operational venue.

Trials Planning

The project team completed the following tasks in preparation for the trials:

- A User Jury methodology was selected. Groups of skilled users from the MSOCs would be briefly trained to use the MVAP, given relevant tasks to perform in a hands-on exercise, and then asked to assess the MVAP apps.

- An early onsite planning session was held in Halifax ten months before the validation event. Nineteen MSOC analysts representing the RCN, Coast Guard, RCMP, and CORA were briefed on MVAP capabilities and gave suggestions that influenced the tasks and datasets for the User Jury.

- The following validation metrics were selected (see Section 2.4): observations, anecdotes, time on task, app ranking, and System Usability Scale (SUS).

- Trials datasets were assembled using archived Global Positioning Warehouse (GPW) data from the MSOCs. In one case it took tens of hours to sift the trial data from a very large GPW archive.

- Scripts were created for both training the participants (Section 3) and for the hands-on exercise (Section 4).

The Use Jury trials were held November 13th and 14th 2013 in a computer lab located in the same building as the MSOC watch floor. Participants were from most of the MSOC agencies, including the Royal Canadian Navy, RCMP, Transport Canada, Canadian Border Services Agency, Department of Fisheries and Oceans, and Coast Guard. Observers' notes, participants' comments, and rankings were collected on four different paper forms, analysed, collated, and transcribed into Tables 1 through 6 of this report. The original hand-written forms are reproduced in Annex B. The only major deviation from the plan was that the observers were not able to accurately estimate the time for each task.

Trials Results

As an overall summary of the success of the MVAP apps, the System Usability Scale results were of particular interest because they could be compared to a large statistical base of similar surveys. The average SUS score was 76/100, which is considered "excellent."

Verbal reports from the participants were even more enthusiastic. As participants arrived for the third session, they reported that there was a "buzz on the watch floor that the MVAP is pretty cool." Some of the glowing comments (paraphrased) included:

- "Between other systems or MVAP, this is the best"

- "Very useful – can't wait to use it, when do we get it?"

- "This is a tool that an analyst would use."

- "The GUI was intuitive enough that participants were trying features without waiting for training"

- "All apps represent concepts that would greatly improve the visual analysis"

Many of the comments indicated that participants were thinking ahead to how they could bring the full advantages of the MVAP to the watch floor. They pointed out for example that it will be necessary to exchange data with existing MSOC systems such as Greenline. They postulated that a flexible and deeper structure could be put in place so that the Analysis Sets can conform to a wide variety of analytical problems. They wondered if the content shown on the Vessel Summary Cards could be user-configurable. They brainstormed about bringing new types of calculated values into the Magnets Grid. They asked whether MVAP could also be used in a context disconnected from the MSOC data grid.

The Map and Timeline app was flagged by some as "the best app of all." Participants appreciated how it visualized time evolution, showed vessels interacting, and displayed Close Encounters information. They stated that it is almost impossible to detect close encounters with the tool suites currently at the MSOCs.

The Magnets Grid app also drew a lot of praise (it was called an "awesome representation" for example) because it offers a completely new way to explore numerical and textual attributes of vessels. Participants particularly admired how they can drag and select a subset of the dots to export as an analysis set.

The trials also revealed ways that the MVAP apps might be improved, and these are also listed in Tables 1 through 6. The best example of this is the need to improve the Time Slider interface used in both the Map and Timeline and the Events Timeline apps, as discussed at length in Section 6.5.

Follow-On Planning

Section 7 discusses options for building on the success of the trials and moving toward installing the apps operationally. It recommends:

- A brief initial study to characterize in detail how MVAP apps must integrate with MSOC systems.

- A prioritized list of enhancements to the MVAP that should or could be done in preparation for deployment.

- A staged deployment that includes validation, training, and long-term support.

8.1   Conclusions

Phase 3 validation of the Maritime Visual Analytics Prototype apps has successfully achieved the contract objectives. User Jury trials conducted with analysts from six MSOC agencies have confirmed that MVAP apps:

- Support rapid awareness and identification of key information elements and thus rapid insight into the meaning of a situation.

- Improve the visualization of the recognized maritime picture.

- Enable better comprehension of a situation and how it could develop.

- Support detection, alerting, and visualization of anomalies.

The resounding conclusion from these trials is that the MVAP apps should be integrated into the MSOCs as soon as possible. In support of that goal, this document has:

- Established rigorous evidence that can be used to promote the MVAP approach to operational users, and

- Provided a description of the steps that need to take place for eventually deploying MVAP to the MSOC.

Annex A   Worksheets Used for the Trials

The following pages show the worksheets that were handed out to the participants and the observers for the scenario-based assessment tasks, as described in Section 4.1:

- **Observer Worksheet:** Observers used this sheet to record their observations during training and tasked activities. Each observer was assigned to one participant, and thus each sheet describes observations of one participant. The completed worksheets are reproduced in Annex B.1.

- **Scenario-Based Worksheet:** Participants used this sheet to record their analysis insights for the six tasks as they progressed through the exercise. These worksheets served primarily to help the participants move in a structured way from task to task. This information was not analysed.

- **System Usability Survey:** Participants ranked the MVAP using a System Usability Survey (SUS) questionnaire, as discussed in Section 2.5. The filled-out SUS sheets are reproduced in Annex B.4.

- **Participant Rankings:** After completing the exercise, participants ranked the apps and provided further comments. The completed worksheets are reproduced in Annex 0.

- **Hot Wash-Up Notes:** Observers kep notes of comments made during the Hot Wash-Up. The completed sheets of notes are reproduced in Annex B.3.

Observer Worksheet

Participant: _____   **Observer:** _____

Questions Asked by the Participant:

Non-Critical Errors During Training:

Non-Critical Errors During the Tasked Exercise:

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

Evidence of Self-Learning (Strategies Improving with Time):

Critical Errors (Participant had to get help to continue):

(Exit Interview is on the other side)

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System Usability Survey

Mark one box in each row.

Strongly disagree   Strongly agree

1. I think that I would like to use these apps frequently

1	2	3	4	5

2. I found the apps unnecessarily complex

1	2	3	4	5

3. I thought the apps were easy to use

1	2	3	4	5

4. I think that I would need the support of a technical person to be able to use these apps

1	2	3	4	5

5. I found the various functions in these apps were well integrated

1	2	3	4	5

6. I thought there was too much inconsistency in these apps

1	2	3	4	5

7. I would imagine that most people would learn to use these apps very quickly

1	2	3	4	5

8. I found the apps very cumbersome to use

1	2	3	4	5

9. I felt very confident using the apps

1	2	3	4	5

10. I needed to learn a lot of things before I could get going with these apps

1	2	3	4	5

Participant Ranking

How valuable would each App be, if integrated into the domain awareness systems that you use:

App Name	Rank 0 - 2 0: not useful 1: possibly useful 2: very useful	Comments
Analysis Set Manager 		
Record Browser 		
Magnets Grid 		
Map and Timeline 		
Timeline 		

Other Comments (will be noted by the observers):

Exit Interview – Group Hotwash

What are your general impressions of how this type of functionality might impact your work?

What were the most useful features/strengths of the applications?

What were the biggest roadblocks in completing the Carnival scenario?

Do you have any thoughts for how the apps could be improved?

Any other thoughts?

Annex B   Raw Notes and Filled-Out Worksheets

Annexes B.1 through B.4 reproduce the original hand-written observations and participant responses from the trials conducted in Halifax in November 2013. These are cross-referenced from the discussion in Section 6 in case there is some question about exactly what was meant by a comment.

B.1   Observations of the Exercise

This Annex shows the hand-written notes that the observers made during the training and the exercise. These are summarized in Section 6, so each note is marked with a code that can be cross-referenced from there. Table 7 is an index into the Observer Notes pages. The total number of observation sheets differs from the number of participants the observation sheets C.1.3.1 and C.1.3.2 are about the same participant.

Table 7 Observer Worksheets

Number	Observer	Time
C.1.1.1	Valérie	
C.1.1.2	Vincent	Nov 13 15:30
C.1.1.3	Bill	
C.1.1.4	Mike	
C.1.2.1	Vincent	
C.1.2.2	Valérie	
C.1.2.3	Bill	Nov 14 10:30
C.1.2.4	Valérie	
C.1.2.5	Mike	
C.1.3.1	Vincent	
C.1.3.2	Valérie and Vincent	Nov 14 13:00
C.1.3.3	Bill	
C.1.3.4	Mike	
C.1.4.1	Bill	
C.1.4.2	Vincent	Nov 14 14:30
C.1.4.3	Valérie	
C.1.4.4	Mike	

Original Observer Worksheet

oculus   13 Nov   DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____

Observer: *Valérie*

Questions Asked by the Participant:

Non-Critical Errors During Training: C.1.1.1a

ASM click search not ok!
after search tried clicking the first and last to select all
Map timeline aligns date on the left and then zooms and desired date is out of view — C.1.1.1b
difficult to position the time line to animate (results did not move because tracks ended within the interval) — C.1.1.1c
RB VSC tried to put left card back to the deck — C.1.1.1d
MG export all instead of selected — C.1.1.1e

Non-Critical Errors During the Tasked Exercise:
ASM click ok instead of search — C.1.1.1f

Evidence of Self-Learning (Strategies Improving with Time):
animate with me handle of timeline on map — C.1.1.1g

looked at textual flags instead of image — C.1.1.1h

Critical Errors (Participant had to get help to continue):
confused between general fetch tracks, compressed track and time bounded
C.1.1.1i

C.1.1.1

Task	Time (min)
Start	.
1	2 min
2	3 min
3	~3 min
4	2 min
5	1 min
6	1 min

oculus

DEFENCE **R&D** DÉFENSE

Observer Worksheet

Participant: ___   Observer: Vincent

Questions Asked by the Participant:

- what your am I in (the Map and timeline)   C.1.1.2a
- what contact are fetched (all between time frame ?)   C.1.1.2b
- Different accuracy

Non-Critical Errors During Training:

- Launch MVAP map and timeline istead of GPW   C.1.1.2c
- Animate track   C.1.1.2d
- Selecting me at the time in Analysis Set   C.1.1.2e

Non-Critical Errors During the Tasked Exercise:

- Using Shift button to select all   C.1.1.2f
- Creating a Vessel group while selected   C.1.1.2g
- Problem dragging into leard Browser   C.1.1.2h
- Shaking layout not ~~time~~ easy   C.1.1.2i

Evidence of Self-Learning (Strategies Improving with Time):

- himself deleted a splitted timeline   C.1.1.2j

Critical Errors (Participant had to get help to continue):

C.1.1.2

Task	Time (min)
Start	4:26
1	4:28 (2 min)
2	(1 min)
3	(5 min)
4	(3 min)
5	(2 min)
6	(2 min)

Bill   START 3 45 pm
                              Training
loculus   end   DEFENCE R&D DÉFENSE
                                                        13 NOV

Observer Worksheet

Participant: _____   Observer: _____Bill_____

Questions Asked by the Participant:
- in hockey cards, update as you move slider | C.1.1.3a |
- fetch "encounters" does not have "searching" feedback
                                    | C.1.1.3b | ~ just stalls on dropdown

Non-Critical Errors During Training:

| C.1.1.3a |

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):
hockey cards success | C.1.1.3c |

Critical Errors (Participant had to get help to continue):

| C.1.1.3d | Using timeline — did not see zoom areas in training

| C.1.1.3e | hit Cancel on GPS fetch

| C.1.1.3f | Search — Select vessels then OK to make set

| C.1.1.3g | timeline — lost yr when zoomed in

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

| C.1.1.3 |

oculus

13 Nov

DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____   Observer: Mike _____

Questions Asked by the Participant:

C.1.1.4a Is there a way to use tools to find all the carnivals

C.1.1.4b Can you important other formats of data?

Non-Critical Errors During Training:

Training first blank → "Name contains..." he tried all pull downs first

Trouble figuring out how to use the timeline - quick to pull, slow to try zooming   C.1.1.4c

C.1.1.4d When opening Record browser, Remi double-clicked and got a single card

When exporting selected Magnets Grid, did not click Radio Button   C.1.1.4e

Loaded a full year's data   C.1.1.4f

Non-Critical Errors During the Tasked Exercise:

- First tried using Magnets Grid
- Opened map and Folded Vessels before setting date   C.1.1.4g
- Didn't open the GPW test

Evidence of Self-Learning (Strategies Improving with Time):

C.1.1.4h Remi tried everything before Eric taught it.
Got ahead of Eric on Carpe Diem search.
        - tried sliding time window

C.1.1.4i Tried to find "Carnival" using other tools

Critical Errors (Participant had to get help to continue):

C.1.1.4j Somehow got two vessels so superimposed after highlighting blue and the drag and drop.

C.1.1.4k Got a blue square on magnets grid, that would not go away.

C.1.1.4m Did not think to flip the card over to get name of flag.   [Carnival Liberty/Valor

Task	Time (min)
Start	
1	4:30
2	~~4:58~~ 5:10
3	7:56
4	~~9~~ 10:14
5	~~10:14~~ 11:05
6	~~11:05~~ 12:45

C.1.1.4

oculus

Observer Worksheet

Participant: _____   Observer: Vincent _____

Questions Asked by the Participant:

- Possible to export subset of vessels   `C.1.2.1a`

Non-Critical Errors During Training: `C.1.2.1b`

- Creating sets not trivial (building folders) adding to it not trivial
- zooming into timeline
- panning with Timeline   `C.1.2.1c`
- SEARCH within add vessels

Non-Critical Errors During the Tasked Exercise:

- zoom into timeline

Evidence of Self-Learning (Strategies Improving with Time):

Task	Time (min)
Start	
1	5 min
2	2 min
3	2 min
4	2 min
5	1 min
6	1 min

Critical Errors (Participant had to get help to continue):

`C.1.2.1`

oculus

Observer Worksheet

Participant: _____   _____   **Observer:** *Valérie*

Questions Asked by the Participant:

(none)

Non-Critical Errors During Training:

went well

Non-Critical Errors During the Tasked Exercise:

went well

Evidence of Self-Learning (Strategies Improving with Time):

did everything as shown in the training

Critical Errors (Participant had to get help to continue):

Task	Time (min)
Start	11h14
1	11h15
2	11h15-11h18
3	11h18-11h20
4	11h20-11h21
5	11h21-11h23
6	11h23-11h24

C.1.2.2

oculus

Nov 14 1030

DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____   Observer: _____Bill_____

Questions Asked by the Participant:

C.1.2.3a double click red encounter to auto zoom to fine + tracks

C.1.2.3b he really likes the timeline

C.1.2.3c would like to export csvs

Non-Critical Errors During Training:

Non-Critical Errors During the Tasked Exercise:

C.1.2.3d search for vessels "search button" awkward
and having to select results one @ a time awkward

C.1.2.3e timeline has 2 zooms
and 2 click drag

C.1.2.3f record browser has rendering error on two lines

Evidence of Self-Learning (Strategies Improving with Time):

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

Critical Errors (Participant had to get help to continue):

C.1.2.3g in going to port in future
he wasn't back in time to
find origin

C.1.2.3h finding date time when in port, I had to say
annotate ship to port then mouse over

C.1.2.3i to use "ship" to see Name of flag

20   artier TR [enter number only: 9999-9991

C.1.2.3

Observer Worksheet

Participant: _____   Observer: _Valérie_

Questions Asked by the Participant:

C.1.2.4a Could I double-click on bottom timeline to select a specific day?

C.1.2.4b VSC Could I see the most recent point?

C.1.2.4c GPW How hard would it be to gain tracks by clicking on the encounter icon

Non-Critical Errors During Training:

C.1.2.4d ASM (Search) hot OK to get the list!
must click

C.1.2.4e Map needed help with timeline
Selected wrong year and could not fetch

C.1.2.4f ASM queued RB with only one ship instead of group

Non-Critical Errors During the Tasked Exercise:

C.1.2.4g M6 selected length instead of tonnage magnet

C.1.2.4h RB selected only one ship at the time
ASM

C.1.2.4i double clicked from M6 and lost M6 context after that
did not see the new tab that was created

Evidence of Self-Learning (Strategies Improving with Time):

C.1.2.4j timeline remained difficult

Critical Errors (Participant had to get help to continue):

C.1.2.4

Task	Time (min)
Start	1114
1	1115
2	1115 - 1117
3	1118 - 1120
4	1120 - 1122
5	1123 - 1124
6	1124 - 1125

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Observer Worksheet

Participant: _____   Observer: **Mike**

Questions Asked by the Participant:

Asked for clarification of the timeline

Can you see top and flip-side of a card at same time? C.1.2.5a

(Problem with text overlapping) C.1.2.5b

Use Gross tonnage to characterize a vessel. – not in Carnival set

Looking at Panube, time line slider is jumpy. C.1.2.5c

~~Non-Critical Errors During Training:~~

Wanted to select all the Carnival vessels, at once. C.1.2.5d

(highlight)

Tried to mouse-over the flag to see the country name

C.1.2.5e

Non-Critical Errors During the Tasked Exercise:

None

Evidence of Self-Learning (Strategies Improving with Ti C.1.2.5f

found the small track bars in the lower timeline

figured out to select from DWL and export to

C.1.2.5g

analysis groups

Tried at various magnet positions and

explained to me what it means. C.1.2.5h

Critical Errors (Participant had to get help to continue):

None.

C.1.2.5

Task	Time (min)		
Start	0:00		
1	1:09 ⇒ 1.09		
2	3:12 ⇒ 2:03		
3	4:32	wait to 6:00	⇒ 1:20
4	6:33 ⇒ 0:33		
5	8:49 ⇒	2:16	
6	9:42 ⇒	1:00	

oculus

NoV

~~Sept~~ 14 1pm

DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____ Observer: Vincent _____

Questions Asked by the Participant:

is it possible to import own vessels C.1.3.1a

Non-Critical Errors During Training:

- SEARCH button C.1.3.1b

- map timeline control C.1.3.1c

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):

Critical Errors (Participant had to get help to continue):

C.1.3.1

Task	Time (min)
Start	
1	1¼ min
2	1 min
3	3 min
4	2 min
5	1 min
6	1 min

Oculus

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Observer Worksheet

Participant: ___ _____   **Observer:** Valérie + Vincent

Questions Asked by the Participant:

C.1.3.2a

C.1.3.2a

Non-Critical Errors During Training:

click ok instead of search

map timeline control difficult at first

Non-Critical Errors During the Tasked Exercise:

went well

Evidence of Self-Learning (Strategies Improving with Time):

opened both ships from MG directly to individual cards instead of RB

C.1.3.2c

Critical Errors (Participant had to get help to continue):

Task	Time (min)
Start	
1	1 min
2	1 min
3	3 min
4	1 min
5	2 min
6	1 min

C.1.3.2

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Observer Worksheet

Participant: _____   Observer: _Bill_

Questions Asked by the Participant:

Non-Critical Errors During Training:

Non-Critical Errors During the Tasked Exercise:

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

Evidence of Self-Learning (Strategies Improving with Time):

- yes - opened record browser w/o a set selection then went back + selected a set

C.1.3.3a

Critical Errors (Participant had to get help to continue):

Had to help use search dialog to find Carnival ships eg "Contains", search button

C.1.3.3b

C.1.3.3

oculus

Nov 14   1 pm

DEFENCE R&D DEFENSE

Observer Worksheet

Participant: _____   Observer: Mike

Questions Asked by the Participant:

C.1.3.4a MVAP Map & timeline: it's hard to see the blue tracks (wiping screen)

C.1.3.4b When exporting from Map & Timeline to Analysis sets do we
have to export all? can we deselect some

C.1.3.4c Magnets Grid is cool.

What does it mean to have a magnet on address?   C.1.3.4d

Non-Critical Errors During Training:

White area in timeline was to wide, so the tracks did not animate

Exercise It would be nice to be able to highlight all the vessels

C.1.3.4f   and export to Analysis Set   C.1.3.4e

Non-Critical Errors During the Tasked Exercise:

C.1.3.4g Asked for "carnival" not "Carnival" when
creating analysis set

Evidence of Self-Learning (Strategies Improving with Time):

C.1.3.4h Tried exporting a set of vessels to Analysis Set
from M.G.
Went straight to Bahamas & time

Critical Errors (Participant had to get help to continue):

Task	Time (min)
Start	
1	50s.
2	30s
3	1:20
4	2
5	0:35
6	1:20

C.1.3.4

Bill   14 Nov
        230 pm

Observer Worksheet

Participant: _   **Observer:** _____

Questions Asked by the Participant:

C.1.4.1a   "buzz on street" 1) this is pretty cool

Non-Critical Errors During Training:

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):

Critical Errors (Participant had to get help to continue):

C.1.4.1b   formed to April 2011

C.1.4.1c   "fetch loiters" not 2012
            because it is a lengthy query executed + stalled the test

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

C.1.4.1

oculus

Nov 14
2³⁰pn

DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____   Observer: _Vincent_____

Questions Asked by the Participant:

Non-Critical Errors During Training:

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):

very good with timelie   C.1.4.2a

Critical Errors (Participant had to get help to continue):

C.1.4.2

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

oculus

Nov 14
2³⁰ Pm

DEFENCE R&D DÉFENSE

Observer Worksheet

Participant: _____   Observer: _____

Questions Asked by the Participant:

C.1.4.3

Non-Critical Errors During Training: C.1.4.3a
ASM   Shift click to select vessels
click MVAP shortcut instead of ASM button to go back to ASM   C.1.4.3b

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):
VSC drag a card to the left before it was explained   C.1.4.3c
C.1.4.3c

Critical Errors (Participant had to get help to continue):

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

Observer Worksheet

Participant: _____   **Observer:** _Mike_

Questions Asked by the Participant:

Asked for an explanation of Close Encounters

C.1.4.4a

Non-Critical Errors During Training:

Needed to 1-on-1 coaching on time line control   C.1.4.4b
Still had trouble..

Non-Critical Errors During the Tasked Exercise:

Evidence of Self-Learning (Strategies Improving with Time):

Critical Errors (Participant had to get help to continue):

Task	Time (min)
Start	
1	
2	
3	
4	
5	
6	

C.1.4.4

B.2 Participant Comments

This Annex shows the hand-written comments written by the participants on the Participant Ranking sheets immediately after the hands-on exercise. These are summarized in Section 6, so each comment is marked with a code so that it can be cross-referenced from there. Table 8 is an index into the Participant Comment pages. One participant did not fill the ranking sheet in the last session.

Table 8 Participant Comments

Number	Association	Role	Time
C.2.1.1	RCN	Coordinator	
C.2.1.2	DFO	Analyst	Nov 13 15:30
C.2.1.3	RCN	Lt(N)	
C.2.1.4	RCN	Intel Officer	
C.2.2.1	RCN	Watch Officer	
C.2.2.2	CCG	Analyst	
C.2.2.3	TC	Analyst	Nov 14 10:30
C.2.2.4	RCN	Lt(N)	
C.2.2.5	TC	Analyst	
C.2.3.1	CBSA	Intel Officer	
C.2.3.2	RCMP	Analyst	Nov 14 13:00
C.2.3.3	DND	RMP Manager	
C.2.4.1			
C.2.4.2		GPW developer	Nov 14 14:30
C.2.4.3			

Original Participant Comments
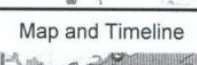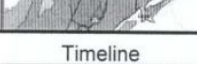
	2: very useful		
Analysis Set Manager	2	The ability to share analysis sets between analysts nd. evident but certainly practical	C.2.1.1a
Record Browser	2	Intensity of ports may not be the only visual – user control of contexts would be useful	C.2.1.1b
Magnets Grid	2	More useful than I thought – certainly dependant on access to data	C.2.1.1c / C.2.1.1d
Map and Timeline	2	Requires different perspective to view effectively greater user control over data in use.	C.2.1.1e / C.2.1.1f
Timeline	2	Not as intuitive however temporal representation is an area we must become more accustomed to using	C.2.1.1g

C.2.1.1
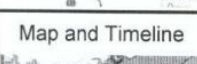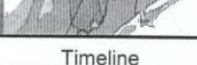
Analysis Set Manager	2	Good that you can Group vessels easily – timeline is very nice.	C.2.1.2a
Record Browser	2	possibility for updating data? online data often out of date.	C.2.1.2b
Magnets Grid	1	drag N select and export capability to Analysis set.	C.2.1.2c
Map and Timeline	2	best part. this is very usefull.	C.2.1.2d
Timeline	1	Good visual from the map Timeline view of time events	C.2.1.2e
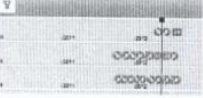
C.2.1.2

Other Comments (will be noted by the observers):

Drag N select bad issues   C.2.1.2f
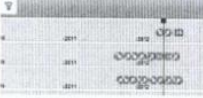
Feature	Rating	Comment	Tag
Analysis Set Manager	2	Great for grouping certain data set.	C.2.1.3a
Record Browser	1	Useful, but a little cumbersome.	C.2.1.3b
Magnets Grid	1	Neat feature, but not sure when I would use it.	C.2.1.3c
Map and Timeline	2	Great for visualizing timeline. Found timeline bar cumbersome.	C.2.1.3d
Timeline	2	Great for comparing tracks of same vessel.	C.2.1.3e

C.2.1.3
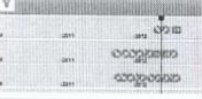
Feature	Rating	Comment	Tag
Analysis Set Manager	2	CREATING A SET, MAYBE DEFAULT TO "SELECT ALL" RATHER THAN HAVING TO SELECT EACH SHIP…	C.2.1.4a
Record Browser	2	GOOD FOR WATCHES.	C.2.1.4b
Magnets Grid	2	YES, ~~ALTHOUGH~~ QUITE PRACTICAL FOR FUZZY ANALYSIS. DEPENDENT ON UNDERLYING FIELDS AS A PRICAL FACTOR	C.2.1.4c
Map and Timeline	2	~~RES~~ SLIDER INTEGRATION NEEDS A LITTLE WORK	C.2.1.4d
Timeline	2	~~REVISE ICONS~~ INCLUDE A LEGEND OF ICONS.	C.2.1.4e
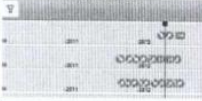
C.2.1.4

Feature	Rating	Comments
Analysis Set Manager	2	
Record Browser	2	
Magnets Grid	2	
Map and Timeline	2	
Timeline	1	
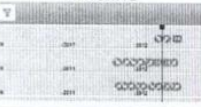
Feature	Rating	Comments
Analysis Set Manager	2	
Record Browser	1	
Magnets Grid	2	
Map and Timeline	2	↓ THESE TWO SEEM THE MOST USEFUL FOR ME
Timeline	2	
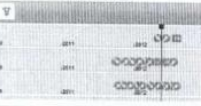
Analysis Set Manager	2		
Record Browser	2		
Magnets Grid	2		
Map and Timeline	2		
Timeline	1		

C.2.2.3

Analysis Set Manager	2		
Record Browser	2		
Magnets Grid	3 1		
Map and Timeline	2		
Timeline	2		

C.2.2.4

C.2.2.4a

Analysis Set Manager	2	
Record Browser	2	
Magnets Grid	2	
Map and Timeline	1	Ran sbw on test platform, would require more time to properly evaluate. (goes for all apps)
Timeline	1	

C.2.2.5

C.2.2.5a

Analysis Set Manager	2	Easy to use
Record Browser	1	Although nice feature easily available.
Magnets Grid	1	Possible limited usage but interesting representation
Map and Timeline	2	Very good representation. Ability to view multiple vessels & their interaction
Timeline	2	Same as above.

C.2.3.1
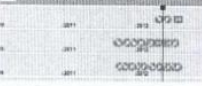
C.2.3.1a

C.2.3.1b

C.2.3.1c

C.2.3.1d

C.2.3.1e

	1: possibly useful 2: very useful	
Analysis Set Manager	2	standard Might be helpful to use functions to select several vessels at a time to add to a subset rather than clicking on each individually.
Record Browser	2	
Magnets Grid	2	
Map and Timeline	2	As habit, I often "right clicked" to search for my options.
Timeline	2	I would prefer to type in the dates than scroll with the slider. A bit cumbersome.

C.2.3.2

C.2.3.2a
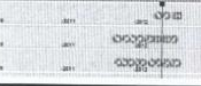
C.2.3.2b

C.2.3.2c

Other Comments (will be noted by the observers): Very useful! Can't w to use

C.2.3.2d

Analysis Set Manager	2	Very clear and easy to understand
Record Browser	2	I would use this "hockey card" concept very much as it is easy to understand
Magnets Grid	1	
Map and Timeline	2	I like visualizing and being able to present where a vessel has been
Timeline	0	Not applicable to my position

C.2.3.3

C.2.3.3a
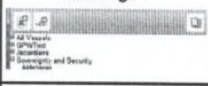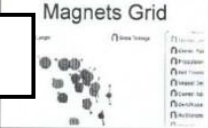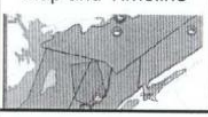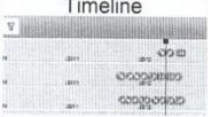
C.2.3.3b

C.2.3.3c

C.2.3.3d

Analysis Set Manager	1	
Record Browser	2	Need a legend, hints, etc to describe info on cards
Magnets Grid	2	Very useful.
Map and Timeline	1	The timeline tool was good for fine grain tuning, but difficult to use with wider time frames.
Timeline	1	

C.2.4.1

C.2.4.1a

C.2.4.1b

C.2.4.1c

Analysis Set Manager	2	ALL APPS REPRESENT CONCEPTS THAM WOULD GREATLY IMPROVE THE VISUALIZED ANALYSIS. BETTER
Record Browser	2	INTEGRATION BETWEEN ALL THE APPS WOULD GO ALL LONG WAY TOWARDS IMPROVING THE USER INTERACTION & EXPERIENCE.
Magnets Grid	2	
Map and Timeline	2	
Timeline	2	

C.2.4.2

C.2.4.2a

C.2.4.2b

Analysis Set Manager	2	Seems very easy to use and create/use groups.	C.2.4.3a
Record Browser	1	Detailed records exist elsewhere, but the scatter of most-visited ports is valuable.	C.2.4.3b
Magnets Grid	2	Awesome interface, easy to use system for comparison of vessels.	C.2.4.3c
Map and Timeline	2	Would be very useful for pattern of life analysis, determining baseline activity	C.2.4.3d
Timeline	2	Link analysis, would help investigating close encounters, fleet activity	C.2.4.3e

Other Comments (will be noted by the observers):

The map and timeline, especially close encounters would be a very useful tool for the MSOC to have... automating a very complex analytical process.

C.2.4.3f

C.2.4.3

B.3   Hot Wash-Up Comments

This Annex shows the hand-written notes made by the observers during the Hot Wash-Up. These are summarized in Section 6, so each comment is marked with a code so that it can be cross-referenced from there. When a Hot-WashUp comment is documented by more than one observer (as is often the case) only one cross-reference is made from Section 6. A comment called "code1" that is the same as comment "code2" and thus not cross-reference is marked as follows: code1 = code2 .

Table 9 is an index into the Hot Wash-Up Comments pages.

Table 9 Hot Wash-Up Comments

Number	Observer	Time
C.3.1.1	Valérie	
C.3.1.2	Vincent	Nov 13 15:30
C.3.1.3	Mike	
C.3.1.4	Bill	
C.3.2.1	Vincent	
C.3.2.2	Valérie	Nov 14 10:30
C.3.2.3	Mike	
C.3.2.4	Bill	
C.3.3.1	Vincent	
C.3.3.2	Valérie	Nov 14 13:00
C.3.3.3	Mike	
C.3.3.4	Bill	
C.3.4.1	Bill	
C.3.4.2	Eric	Nov 14 14:30
C.3.4.3	Valérie	

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Original Hot Washups

Comment

C.3.1.1a   it's nice to see encounter icons directly on the map

exit interview:

- map and timeline good   C.3.1.1b = C3.1.3a
  like to animate and search for encounter   C.3.1.1c = C3.1.3b

- encounter within a box or with a single/group of vessel   C.3.1.1d = C3.1.3c

- magnets grid good   C.3.1.1e = C3.1.3d
  difficult to create new magnets must use exact name   C.3.1.1f = C3.1.3e

- biggest roadblock: time scale is tricky
  difficult to pick a very specific time   C.3.1.1g = C3.1.3f

- VSC turn on/off features
  configurable, not fixed   C.3.1.1h = C3.1.3j

- would need to be able to export results   C.3.1.1i = C3.1.3k
  here 50 fishing vessels   Share analysis
  ask with plane flew above
  ask same thing to some one else   C.3.1.1j
  put all data back together in the tool

- analysis story needs to be traceable   C.3.1.1k

- be able to take a save of what we were doing and load back later   C.3.1.1m = C3.1.3k

- interesting to import other type of data AIS + VMS   C.3.1.1n

C.3.1.1

Record Browser

C.3.1.2a - two sides not in sync?
- multiple cards on left

Merged Card

Calculated attribute

C.3.1.2c = C3.1.3a   Map and timeline very good even for small
amount of vessels. Search for encounters and go back
C.3.1.2d = C3.1.3b   in time.
- 2 ways
C.3.1.2e = C3.1.3c   - encounters in area
- encounters from specific vessels

C.3.1.2f = C3.1.3e   fields, a drop down menu for merged's grid
C.3.1.2g = C3.1.3f   - Roadblocks → timescale
- be able to pick a specific date or time
C.3.1.2h = C3.1.3h
- tracker cards (turn on features on cards)
C.3.1.2i = C3.1.3j
- Exporting Results
- worktable interface !!

C.3.1.2

like Map & timeline - if you can handle large data. `C.3.1.3a`

" Like searching for events (eg encounters) `C.3.1.3b`

: need two encounter searches:
  - who encountered my ship?
  - from all ships, `C.3.1.3c`

: found magnets grid more useful than expected. `C.3.1.3d`

: Magnets grid should offer pull-down selectors on record fields `C.3.1.3e`

everyone: very difficult to become proficient with the time scale `C.3.1.3f`

: iPhone is better: scroll up to find date time `C.3.1.3g`
- there are many people coming & going
- p just let me type in the date `C.3.1.3h`

: if you zoom until orange handles are off-screen, you get stuck `C.3.1.3i`

: configurable hockey cards
  eg: no word cloud? `C.3.1.3j`

: export the results, put in a relevant directory structure `C.3.1.3k`

: export the context so that collaborators can go there

  - Create a story...

: we need to be able to see the work session

It is powerful to be able to import spreadsheets with VMS tracks. `C.3.1.3m`

`C.3.1.3`

What are your general impressions of how this type of functionality might impact your work?

C.3.1.4a

— when do we get this? you have it
— Now just have to make it work

C.3.1.4b = C3.1.3c   C.3.1.4c = C3.1.3a   C.3.1.4d = C3.1.3b

What were the most useful features/strengths of the applications?

2 ways to start
- geo select
- visual select

— map + timeline good — if we can import our data
  + animation is killer — to see interactions
— search for encounter + go back in tracks awesome + behavior

C.3.1.4e = C3.1.3d

— found msg grid more useful than expected but
  depends on avail fields

C.3.1.4f

What were the biggest roadblocks in completing the Carnival scenario?

C.3.1.4g = C3.1.3f
— time line is tricky (lost yr when zoomed in)
C.3.1.4h = C3.1.3g
— may come from experience but needs to be
  immed. useful (cold)
C.3.1.4i = C3.1.3h
— better to enter

Do you have any thoughts for how the apps could be improved?

C.3.1.4j = C3.1.3j
— on tricky cards, turn on/off encounters
) needs to be configurable

Any other thoughts?

C.3.1.4m = C3.1.1j

C.3.1.4k = C3.1.3k
— Struct results so shareable
— each problem is always diff
  so need flex analysis set hierarchy
    dir, groups,   → air data
C.3.1.4n   vessel data
      → its like a recipe   which aircraft
                                     overflew vessels?
                                                labels?

C.3.1.4o — fisheries analysis — how load any data file?
              eg VMS pull   12 Nov 2013   "file reader"
                                            (eg alert results

C.3.1.4p

C.3.1.4

C.3.2.1a → tool that analyst would use

C.3.2.1b = C3.2.3f → at first it is a bit confusing, but with practice it is very usefull

C.3.2.1c = C3.2.3h → a little clunck, adds a click to jump straight to a specific date

C.3.2.1d → Maybe most unique of all apps
— time saver

C.3.2.1e = C3.2.3m,n → Exporting results to other

C.3.2.1

Notes: training more detailed about

C.3.2.2a   Could we configure the encounter size?

exit interview:

C.3.2.2b = C3.2.3f — timeline is usefull but difficult to use at first

C.3.2.2c = C3.2.3h — pop-up for exact date and duration

C.3.2.2d = C3.2.3d — MG is best tool ever seen

C.3.2.2e = C3.2.3m,n — export to share is important
KML great
list of ship

C.3.2.2f = C3.2.3o — magnet with a boundary area
trip wire events could be created and store in event database

C.3.2.2g = C3.2.3q — purpose of arrows in MG was not obvious at first for one participant

C.3.2.2

C.3.2.3a | It would be good to save a session and context so we could come back to it.

C.3.2.3b : Can these be passed on, element-by-element? for example so that Greenline can integrate them

C.3.2.3c : Why just the watch floor? Why not MSOC. MDOUS was very wet.

C.3.2.3d : Pulling magnets is way better than reviewing line-by-line. Very useful.

C.3.2.3e : Want a toolbox on the dashboard, so can pull a tool when needed.

C.3.2.3f : Timeline confusing at first but get used to it

C.3.2.3g Timeline is a favourite feature

C.3.2.3h : Clunky: need to add have type-in option.

C.3.2.3i : Timeline both-end.

C.3.2.3j : Calendar pop-up.

C.3.2.3k Widespread appreciation of Magnets grid.

C.3.2.3m : Greenline lets you export to other analysts.

C.3.2.3n : export to Google Earth? Y.

C.3.2.3o : want a Magnets Grid calculator based on trip wires, choke points POIs.

C.3.2.3p : why not include trip wire events

C.3.2.3q : what were the arrows on M.Grid.

C.3.2.3r : use sliding timelines to find polluters - when ships move through.

C.3.2.3

Exit Interview – Group Hotwash

What are your general impressions of how this type of functionality might impact your work?

C.3.2.4a

~ Between Greeline, Project Modes (very weak) the MVAP is the best

C.3.2.4b = C3.2.3f

~ These are very useful should be part of dashboards

What were the most useful features/strengths of the applications?

C.3.2.4c = C3.2.3k

Magnets is great – big time saver

C.3.2.4d = C3.2.3g

for ., timeline was his favorite feature

What were the biggest roadblocks in completing the Carnival scenario?

C.3.2.4e = C3.2.3f

the timeline was confusing @ first but with practice great

C.3.2.4f = C3.2.3h

felt timeline little clunky – would be helpful to input exact date too on double click to go to exact

Do you have any thoughts for how the apps could be improved?

C.3.2.4g = C3.2.3a

- export to CSV ~ export what you are working on

C.3.2.4h = C3.2.3a

- save search so can redo again for updates

C.3.2.4i = C3.2.3o

→ use a geo region as a magnet (tripwires, RoI) or went thru choke point

Any other thoughts?

C.3.2.4j = C3.2.3r

- slidable event timelines
  - useful for polluters (get date-time of slider)
  and find ships interactively

C.3.2.4

C.3.3.1a — a bug de magnets grid selection werner "stop showing"

C.3.3.1b = C.3.3.3a — be able to type a specific date in the map timeline

C.3.3.1c = C.3.3.3b — use the map timeline to do reporting. Use as a playback

C.3.3.1c = C.3.3.3d — interaction between vessels is nice

C.3.3.1d = C.3.3.3e — the alignment of timeline and split of timeline is nice

C.3.3.1e = C.3.3.3g — Magnets used to pull apart vessels for flag — year built

C.3.3.1

Notes:

C.3.3.2a — when one vessel is very different, all the other stay together in MG. (Panuke sea problem)

Interview:

C.3.3.2b = C.3.3.3a timeline enter dates

C.3.3.2c = C.3.3.3b have a play button to show animation, export a video playback or link or data file that can be play on widget

C.3.3.2d — encounters seen visually is good

C.3.3.2e = C.3.3.3f — multi-timelines, looking at ports of call would be interesting. Sync on next port and look at previous

C.3.3.2c

C.3.3.2f = C.3.3.3e — MG would be useful

C.3.3.2g — export to google earth and then add pretty labels for presentations

C.3.3.2h close encounter icon for a specific time window

C.3.3.2

C.3.3.3a Liked visual aspect of Timeline – to better to just type in dates. Might get used to it.

C.3.3.3b : When analysing a play – uses the timeline to animate the story. Hit button to "play"

C.3.3.3c – export to CSV on video

C.3.3.3d : liked interactions/encounters events

C.3.3.3e liked multi-timelines with unlocked shifting

VL Q: what events?

C.3.3.3f A: synchronizer on arrival at a specific point.

C.3.3.3g Really liked the magnets – look for newer builds, flag, country of registry.

C.3.3.3h How can we view discrete events better?
A : assign flag to dot colour

C.3.3.3i : like how you can select individuals in MG and export as a set.

C.3.3.3j Q: Can we manually import our own data (ie not from GPW)
A: Yes: there is a script you can use.

C.3.3.3k We'd be interested in using this isolated from the big databases.

C.3.3.3m Can we get better maps?

C.3.3.3n :Can we export a set to Excel?
A: Can export to KML.

C.3.3.3

Exit Interview – Group Hotwash

What are your general impressions of how this type of functionality might impact your work?

`C.3.3.4a = C3.3.3c` would use timeline to do a briefing (reporting)

What were the most useful features/strengths of the applications?

`C.3.3.4b = C3.3.3d` — Visual represent."

`C.3.3.4c = C3.3.3e` — encounters / interactions of vessels
— liked events on multiple timeline
eg. ports of call

`C.3.3.4d = C3.3.3g` — really liked the magnets eg to find newer builds
eg. country of register

What were the biggest roadblocks in completing the Carnival scenario?

Do you have any thoughts for how the apps could be improved?

`C.3.3.4e = C3.3.3a` would like to type in dates

`C.3.3.4f = C3.3.3b` add a "play" button

`C.3.3.4g = C3.3.3h` using qualitative fields in mag grid
— ~~can we manually~~

Any other thoughts?

`C.3.3.4h = C3.3.3m` higher rez base maps

C.3.3.4

Exit Interview – Group Hotwash

What are your general impressions of how this type of functionality might impact your work?

C.3.4.1a — This would be useful for link analysis

C.3.4.1b — This is awesome

What were the most useful features/strengths of the applications?

C.3.4.1c — close encounter tool is sweet
↳ now there is no way to do automatically
now almost impossible to do

C.3.4.1d — app Concepts are all bang on

What were the biggest roadblocks in completing the Carnival scenario?

C.3.4.1e — interaction between apps
eg. Create a vessel group of all "Carnival"
directly from map
eg go straight to hockey cards straight from map

Do you have any thoughts for how the apps could be improved?

C.3.4.1f — 10 km close encounter should be configurable

C.3.4.1g — for counting "Carnivals" on map, need a filter

C.3.4.1h — retrieving a track puts the icon @ start of track not where the time line is

Any other thoughts?

C.3.4.1i — Should have a textual list of close encounters too

C.3.4.1j — Nice to say % chance of close encounter
eg. includes a stop
Not just a passing

— ~~Steve~~ broke system twice this is a prototype

C.3.4.1k — timeline takes 20 mins to get easier
↳ something needs to be simpler
↳ double click to set date

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C.3.4.1

Exit Interview – Group Hotwash

Session 4

What are your general impressions of how this type of functionality might impact your work?

C.3.4.2a = C3.4.1a — Link analysis - find related vessels (record browser / magnets grid)

C.3.4.2b = C3.4.1c — Close encounters - currently go back in time + look @ snapshots, "almost impossible"

What were the most useful features/strengths of the applications?

What were the biggest roadblocks in completing the Carnival scenario?

C.3.4.2c = C3.4.1e — Interaction between apps
- GPW → search / magnets grid

C.3.4.2d — Navigate from any widget to any other

Do you have any thoughts for how the apps could be improved?

C.3.4.2e = C3.4.1j — Degree of certainty encounter occurred.

C.3.4.2f = C3.4.1i — Text list of encounters

C.3.4.2g — Double click snap to date
- also for close encounters

Any other thoughts?

C.3.4.2

B.4   Filled-Out System Usability Survey Sheets

The following pages show the original System Usability Sheets that were collected from the participants. Two participants did not fill the survey in the last session.

Original System Usability Survey

DEFENCE **R&D** DÉFENSE

Nov 14
10 30

oculus

1
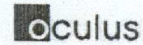
System Usability Survey

Session #: 2   Participant #: 5

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

				✓
1	2	3	4	5

2. I found the apps unnecessarily complex

	✓			
1	2	3	4	5

3. I thought the apps were easy to use

			✓	
1	2	3	4	5

4. I think that I would need the support of a technical person to be able to use these apps

✓				
1	2	3	4	5

5. I found the various functions in the apps were well integrated

			✓	
1	2	3	4	5

6. I thought there was too much inconsistency in the apps

✓				
1	2	3	4	5

7. I would imagine that most people would learn to use the apps very quickly

		✓		
1	2	3	4	5

8. I found the apps very awkward to use

	✓			
1	2	3	4	5

9. I felt very confident using the apps

				✓
1	2	3	4	5

10. I needed to learn a lot of things before I could get going with these apps

✓				
1	2	3	4	5

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System Usability Survey

Session #: 2   Participant #: 2

Mark one box in each row.

	Strongly disagree				Strongly agree
	1	2	3	4	5
1. I think that I would like to use these apps frequently					✓
2. I found the apps unnecessarily complex		✓			
3. I thought the apps were easy to use				✓	
4. I think that I would need the support of a technical person to be able to use these apps		✓			
5. I found the various functions in the apps were well integrated				✓	
6. I thought there was too much inconsistency in the apps	✓				
7. I would imagine that most people would learn to use the apps very quickly				✓	
8. I found the apps very awkward to use	✓				
9. I felt very confident using the apps				✓	
10. I needed to learn a lot of things before I could get going with these apps		✓			

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System Usability Survey

Session #: 2   Participant #: 6

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

1	2	3	4 ✓	5

2. I found the apps unnecessarily complex

1	2 ✓	3	4	5

3. I thought the apps were easy to use

1	2	3	4 ✓	5

4. I think that I would need the support of a technical person to be able to use these apps

1	2 ✓	3	4	5

5. I found the various functions in the apps were well integrated

1	2	3 ✓	4	5

6. I thought there was too much inconsistency in the apps

1 ✓	2	3	4	5

7. I would imagine that most people would learn to use the apps very quickly

1	2	3 ✓	4	5

8. I found the apps very awkward to use

1	2 ✓	3	4	5

9. I felt very confident using the apps

1	2	3	4 ✓	5

10. I needed to learn a lot of things before I could get going with these apps

1 ✓	2	3	4	5

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Nov 14 1030

oculus

System Usability Survey

Session #:___   Participant #:___

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

1   2   ③   4   5

2. I found the apps unnecessarily complex

I would update the timeline to double click to jump to a specific date rather than use the slider

1   ②   3   4   5

3. I thought the apps were easy to use

I would add a click to a "red box" encounter to see encounter rather than using timeline to search the date

1   2   ③   4   5

4. I think that I would need the support of a technical person to be able to use these apps

①   2   3   4   5

5. I found the various functions in the apps were well integrated

1   2   3   ④   5

6. I thought there was too much inconsistency in the apps

①   2   3   4   5

7. I would imagine that most people would learn to use the apps very quickly

1   2   3   ④   5

8. I found the apps very awkward to use

1   ②   3   4   5

9. I felt very confident using the apps

1   2   3   ④   5

10. I needed to learn a lot of things before I could get going with these apps

I would need more time to think about some of the ways this could integrate this into my job.

1   ②   3   4   5

12 Nov 2013

Nov 14
1030

System Usability Survey

Session #: 2   Participant #: ___

Mark one box in each row.

	Strongly disagree				Strongly agree
1. I think that I would like to use these apps frequently	1	2	✓ 3	4	5
2. I found the apps unnecessarily complex	1	✓ 2	3	4	5
3. I thought the apps were easy to use	1	2	3	✓ 4	5
4. I think that I would need the support of a technical person to be able to use these apps	1	✓ 2	3	4	5
5. I found the various functions in the apps were well integrated	1	2	3	✓ 4	5
6. I thought there was too much inconsistency in the apps	1	✓ 2	3	4	5
7. I would imagine that most people would learn to use the apps very quickly	1	2	3	4	✓ 5
8. I found the apps very awkward to use	✓ 1	2	3	4	5
9. I felt very confident using the apps	1	2	✓ 3	4	5
10. I needed to learn a lot of things before I could get going with these apps	✓ 1	2	3	4	5

12 Nov 2013

DEFENCE ![RDDC logo] **DÉFENSE**

Nov 14   oculus 6
1 pm

System Usability Survey

Session #:___   Participant #: ___

Mark one box in each row.

		Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

| | 1 | 2 | 3 | 4 | 5 ✓ |

2. I found the apps unnecessarily complex

| | 1 | 2 ✓ | 3 | 4 | 5 |

3. I thought the apps were easy to use

| | 1 | 2 | 3 | 4 ✓ | 5 |

4. I think that I would need the support of a technical person to be able to use these apps

| | 1 ✓ | 2 | 3 | 4 | 5 |

5. I found the various functions in the apps were well integrated

| | 1 | 2 | 3 | 4 ✓ | 5 |

6. I thought there was too much inconsistency in the apps

| | 1 ✓ | 2 | 3 | 4 | 5 |

7. I would imagine that most people would learn to use the apps very quickly

| | 1 | 2 | 3 | 4 ✓ | 5 |

8. I found the apps very awkward to use

| | 1 | 2 ✓ | 3 | 4 | 5 |

9. I felt very confident using the apps

| | 1 | 2 | 3 | 4 ✓ | 5 |

10. I needed to learn a lot of things before I could get going with these apps

| | 1 ✓ | 2 | 3 | 4 | 5 |

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oculus

Nov 14 /pm

System Usability Survey

Session #:___ Participant #:___

Mark one box in each row.

	Strongly disagree				Strongly agree
	1	2	3	4	5

1. I think that I would like to use these apps frequently — X at 3

2. I found the apps unnecessarily complex — X at 4

3. I thought the apps were easy to use — X at 3

4. I think that I would need the support of a technical person to be able to use these apps — X at 4

5. I found the various functions in the apps were well integrated — X at 3

6. I thought there was too much inconsistency in the apps — X at 1

7. I would imagine that most people would learn to use the apps very quickly — X at 2

8. I found the apps very awkward to use — X at 3

9. I felt very confident using the apps — X at 1

10. I needed to learn a lot of things before I could get going with these apps — X at 4

12 Nov 2013

8

Nov 14 1 pm

oculus

System Usability Survey

Session #:___   Participant #: ___

Mark one box in each row.

		Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently
   - 1 | 2 | 3 | 4 | 5 → ✓ at 5

2. I found the apps unnecessarily complex
   - 1 | 2 | 3 | 4 | 5 → ✓ at 5

3. I thought the apps were easy to use
   - 1 | 2 | 3 | 4 | 5 → ✓ at 5

4. I think that I would need the support of a technical person to be able to use these apps
   - 1 | 2 → ✓ | 3 | 4 | 5

5. I found the various functions in the apps were well integrated
   - 1 | 2 | 3 | 4 → ✓ | 5

6. I thought there was too much inconsistency in the apps
   - 1 → ✓ | 2 | 3 | 4 | 5

7. I would imagine that most people would learn to use the apps very quickly
   - 1 | 2 | 3 | 4 | 5 → ✓

8. I found the apps very awkward to use
   - 1 → ✓ | 2 | 3 | 4 | 5

9. I felt very confident using the apps
   - 1 | 2 | 3 | 4 | 5 → ✓

10. I needed to learn a lot of things before I could get going with these apps
    - 1 → ✓ | 2 | 3 | 4 | 5

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oculus 9

System Usability Survey

Session #:___   Participant #: ___

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

1	2	3	4 (X)	5

2. I found the apps unnecessarily complex

1 (X)	2	3	4	5

3. I thought the apps were easy to use

1	2	3	4 (X)	5

4. I think that I would need the support of a technical person to be able to use these apps

1	2 (X)	3	4	5

5. I found the various functions in the apps were well integrated

1	2	3	4 (X)	5

6. I thought there was too much inconsistency in the apps

1 (X)	2	3	4	5

7. I would imagine that most people would learn to use the apps very quickly

1	2	3	4 (X)	5

8. I found the apps very awkward to use

1	2 (X)	3	4	5

9. I felt very confident using the apps

1	2	3	4 (X)	5

10. I needed to learn a lot of things before I could get going with these apps

1 (X)	2	3	4	5

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oculus

System Usability Survey

Session #:_____   Participant #:_____

Mark one box in each row.

	Strongly disagree				Strongly agree
	1	2	3	4	5

1. I think that I would like to use these apps frequently — **5** (X)

2. I found the apps unnecessarily complex — **4** (X)

3. I thought the apps were easy to use — **4** (X)

4. I think that I would need the support of a technical person to be able to use these apps — **4** (X)

5. I found the various functions in the apps were well integrated — **3** (SLIDER) (X)

6. I thought there was too much inconsistency in the apps — **2** (X)

7. I would imagine that most people would learn to use the apps very quickly — **5** (X)

8. I found the apps very awkward to use — **3** (X)

9. I felt very confident using the apps — **5** (X)

10. I needed to learn a lot of things before I could get going with these apps — **1** (X)

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13 ♪ ✓

oculus

System Usability Survey

Session #:___   Participant #: ___

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently

1	2	3	4	5
				✓

2. I found the apps unnecessarily complex

1	2	3	4	5
x				

3. I thought the apps were easy to use

1	2	3	4	5
			x	

4. I think that I would need the support of a technical person to be able to use these apps

1	2	3	4	5
x				

5. I found the various functions in the apps were well integrated

1	2	3	4	5
			x	

6. I thought there was too much inconsistency in the apps

1	2	3	4	5
	x			

7. I would imagine that most people would learn to use the apps very quickly

1	2	3	4	5
				x

8. I found the apps very awkward to use

1	2	3	4	5
x				

9. I felt very confident using the apps

1	2	3	4	5
				x

10. I needed to learn a lot of things before I could get going with these apps

1	2	3	4	5
x				

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13 Nov ✓   **o**culus

System Usability Survey   Session #:___   Participant #: ___

Mark one box in each row.

		Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently — ✓ at 4
   1   2   3   4   5

2. I found the apps unnecessarily complex — ✓ at 1
   1   2   3   4   5

3. I thought the apps were easy to use — ✓ at 4
   1   2   3   4   5

4. I think that I would need the support of a technical person to be able to use these apps — ✓ at 2
   1   2   3   4   5

5. I found the various functions in the apps were well integrated — ✓ at 4
   1   2   3   4   5

6. I thought there was too much inconsistency in the apps — ✓ at 1
   1   2   3   4   5

7. I would imagine that most people would learn to use the apps very quickly — ✓ at 3
   1   2   3   4   5

8. I found the apps very awkward to use — ✓ at 2
   1   2   3   4   5

9. I felt very confident using the apps — ✓ at 4
   1   2   3   4   5

10. I needed to learn a lot of things before I could get going with these apps — ✓ at 1
   1   2   3   4   5

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Nov 14 230 pm   **o**culus

System Usability Survey

Session #:___   Participant #:___

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently — **X in box 5**
   (1, 2, 3, 4, 5)

2. I found the apps unnecessarily complex — **X in box 2**
   (1, 2, 3, 4, 5)

3. I thought the apps were easy to use — **X in box 4**
   (1, 2, 3, 4, 5)

4. I think that I would need the support of a technical person to be able to use these apps — **X in box 2**
   (1, 2, 3, 4, 5)

5. I found the various functions in the apps were well integrated — **X in box 4**
   (1, 2, 3, 4, 5)

6. I thought there was too much inconsistency in the apps — **X in box 2**
   (1, 2, 3, 4, 5)

7. I would imagine that most people would learn to use the apps very quickly — **X in box 4**
   (1, 2, 3, 4, 5)

8. I found the apps very awkward to use — **X in box 2**
   (1, 2, 3, 4, 5)

9. I felt very confident using the apps — **X in box 3**
   (1, 2, 3, 4, 5)

10. I needed to learn a lot of things before I could get going with these apps — **X in box 1**
    (1, 2, 3, 4, 5)

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Nov 14 230^{pm} 14

oculus

System Usability Survey

Session #:___   Participant #: ___

Mark one box in each row.

	Strongly disagree				Strongly agree

1. I think that I would like to use these apps frequently — 3

2. I found the apps unnecessarily complex — 3

3. I thought the apps were easy to use — 4

4. I think that I would need the support of a technical person to be able to use these apps — 2

5. I found the various functions in the apps were well integrated — 3

6. I thought there was too much inconsistency in the apps — 2

7. I would imagine that most people would learn to use the apps very quickly — 4

8. I found the apps very awkward to use — 3

9. I felt very confident using the apps — 3

10. I needed to learn a lot of things before I could get going with these apps — 2

Scale: 1 2 3 4 5

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Annex C   References

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List of symbols/abbreviations/acronyms/initialisms

App	Application Software, also: Widget
ARP	Advanced Research Project
ASM	Analysis Set Manager
CBSA	Canada Border Services Agency
CCG	Canadian Coast Guard
CORA	Centre for Operational Research and Analysis
DFO	Department of Fisheries and Oceans
DRDC	Defence Research & Development Canada
GPW	Global Positioning Warehouse
GUI	Graphical User Interface
IRCS	International Radio Call Sign
ISTIP	Intelligence Science and Technology Integration Platform
IT	Information Technology
LCdr	Lieutenant Commander
MDA	Maritime Domain Awareness
MG	Magnets Grid
MS	Microsoft
MSOC	Marine Security Operations Centre
MVAP	Maritime Visual Analytic Prototype
NATO	North Atlantic Treaty Organization
PAVM	Prototype d'Analyse Visuelle Maritime
POI	Person of Interest
RCMP	Royal Canadian Mounted Police
RCN	Royal Canadian Navy
RMP	Recognized Maritime Picture
ROI	Region of Interest
SUS	System Usability Scale
VA	Visual Analytics
VOI	Vessel of Interest
VTS	Vessel Tracking System
WAS	Widget Application Shell